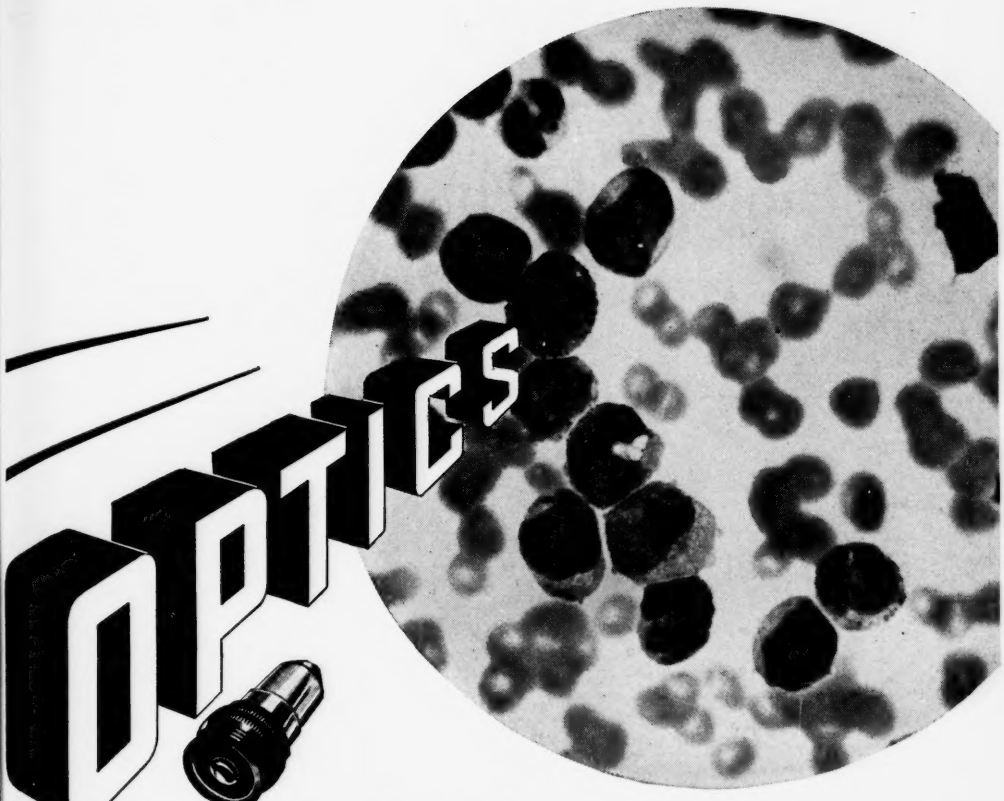

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Journal of the Biological Photographic Association

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VOLUME IV *September, 1935* NUMBER 1

The Journal of the Biological Photographic Association

ON TO CHICAGO TO THE FIFTH ANNUAL CONVENTION OF THE BIOLOGICAL PHOTOGRAPHIC ASSOCIATION

The Place: THE STEVENS, the World's Largest Hotel, Michigan Avenue, 7th and 8th Streets, Chicago

The Time: September 12, 13, 14, 1935

Our Conventions—two in New Haven, Connecticut, one in Rochester, New York, and one in New York City—have thus far been held in the East, where the membership of our Association is strongest. We are happy now to "go West," in order to make it easy for our growing Western membership to partcipate in this phase of our activities. It is hoped that a goodly number of our widely distributed members will find it possible to attend. Personal contacts and exchange of ideas at these gatherings should prove very valuable.

The Committees, under the efficient guidance of Mr. Ralph P. Creer, who organized this Association and was its president during the first three years, have prepared a varied and interesting program. It has been planned so as to give ample time for informal social contacts, experience having taught us that a program must not be too long, no matter how high may be its quality.

We shall occupy a handsome suite of rooms at The Stevens. The West Ball Room of this hotel will be used for lectures and demonstrations. On the walls of the adjoining South Ball Room the Print Exhibition will be hung. In its center the scientific and technical apparatus will be exhibited, together with the transparencies. There are several smaller rooms and alcoves all in convenient relation to the elevators and

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check rooms. With all our activities conveniently and compactly placed, no time should be lost, and ample opportunity will be afforded to study in detail the new and improved apparatus and materials which contribute so much to an increase of our output and an improvement of our technique.

Because these very satisfactory facilities have been offered us by The Stevens, we have chosen it for our headquarters. We urge our members to make their reservations early, so as to secure rooms at the rate quoted. to our Committee, which is $3.00 for a single room with bath, other accommodations being in proportion.

We have sent you a number of communications urging your active participation in the management of your Association. These consist of the following: a proposed amendment to the constitution; the names of the members of the Nominating Committee, with a request that you write concerning your preferences of the officers and directors to be nominated, as they will come up for election at the Chicago meeting; and finally, all the information about the Exhibition of photographs, which you are to aid by contributing some of your best prints.

This collection of prints will become our *Second Travelling Salon*, which we hope will greatly surpass the first; it will be widely exhibited, thus contributing to the prestige of the Association and its members. If you are coming to Chicago, you will wish your prints placed in the Exhibition, to compare their quality and your methods with the work of your fellow craftsmen. If you are unable to come, it is even more important that you be represented by some of your work, and be with us in spirit.

Any color photographs or color transparencies will be returned to members after the close of the Convention, if so requested, but a donation of such material will be appreciated, as it will greatly add to the value of the Salon.

It is urged upon our members, as individuals and in groups, to sponsor the exhibition of these Salons in their home towns; and it is suggested, if you feel so inclined, that some of your own work be added. As the first Salon does not include color work, it would be very desirable to add to it such color photographs as you can furnish.

Very great interest has been shown in our Conventions in the general discussion sessions. In order that these periods may be made as in-

teresting and instructive as possible, you should send to Mr. Creer, in advance of the meetings a short abstract of the questions you intend to ask or the information you wish to impart, so that the presentation may be properly organized.

LOUIS SCHMIDT,
President, Biological Photographic Association.

COMPOSING SUBMARINE LANDSCAPES FOR PHOTOGRAPHIC REPRODUCTION*

TORSTEN GISLÉN AND GUSTAF ÒDQUIST
Lund, Sweden

In the course of investigations carried out in 1926–1929 on animal and plant communities of the Gullmar Fjord (cf. Kristinebergs Zoologiska Station 1877–1927, Parts 3, 4, Stockholm, 1929, 1930), a number of photographs were taken of marine landscapes assembled for the purpose in laboratory aquaria (op. cit. Pls. 2–6). These landscapes were arranged on the basis of careful field records made under water by one of the present authors (Gislén), who used a commercial diving outfit. The photographic results are the work of the junior author (Òdquist). In the present paper some additional photographs are given.

As it may be of some interest to the reader to know the conditions under which these photographs were obtained, we have undertaken to describe our method of preparing or setting up submarine landscapes for photographing.

Previously, in settings of living objects in aquaria, all animals, plants, stones, and the like, which were to be photographed, were usually very thoroughly cleaned, evidently with the intention of keeping the aquarium water as clear as possible (cf. e.g. F. Martin Duncan, Denizens of the Deep, London, 1907). Quite obviously this method is very useful when one wishes merely to reproduce the outer form of a plant or an animal, but it is very unsatisfactory when one desires to portray living marine organisms in their natural surroundings.

* From Zoologiska Institutionen. Received for publication May 21, 1935.

In staging an aquarium picture for the purpose of presenting as accurately as possible the natural appearance of a sea bottom of a given type, the first requirement is that all objects to be photographed, originate from a bottom of the type which one is going to reproduce. This not only applies to the plants and animals, but also to the stones, gravel, shell-sand, etc. characteristic of the bottom in question. All cleansing should be avoided except the removal of such foreign debris as may become attached to the objects in the course of being hauled up in the dredge from the sea-bottom.

In many cases during our experiments in posing animal life, on a shelly bottom, for example, we found it necessary in order to create a natural impression, to sieve sand and mud over the dead substratum. After the heaviest particles had settled, pure sea-water was allowed to run gently through the aquarium until all suspended material had been carried away. Afterwards, the living organisms were placed in the aquarium. When the animals had adapted themselves to their surroundings and had taken on a natural appearance suitable for photographing, the exposures were made. It often took considerable time, more than a month in some cases, from the time of preparing the aquarium until it was possible to obtain a successful photograph. Thus we had to have at our disposal a large number of aquaria of different sizes in which the artificial submarine landscapes could be allowed to "ripen."

The aquaria used were generally rather small, holding, as a rule, 70–80 liters; occasionally larger aquaria of 300–400 liters capacity were used. The glass wall of the aquarium should be plate glass.

Scientific photography of submarine objects in aquaria often is both time-consuming and trying to one's patience, but it is an occupation which is entertaining and interesting. The painstaking preparation which includes dredging or diving; the reconstruction of the submarine landscapes with the guidance of the dredging journal or diving record; the clearing of the water; the waiting for the animals to expand or otherwise become established; the arrangement of the illumination, etc., involve so much time and thought that it is a real joy for the photographer when at last the aquarium is ready for photographing.

Some workers recommend that the aquarium be placed out of doors and that the exposure be made in direct sunlight. We have, however, always taken our pictures by electric light for several reasons. The photographs can be made either by day or night regardless of the weather.

The illumination can easily be altered as necessary. When photographing from above, one can arrange the light without any difficulty in such

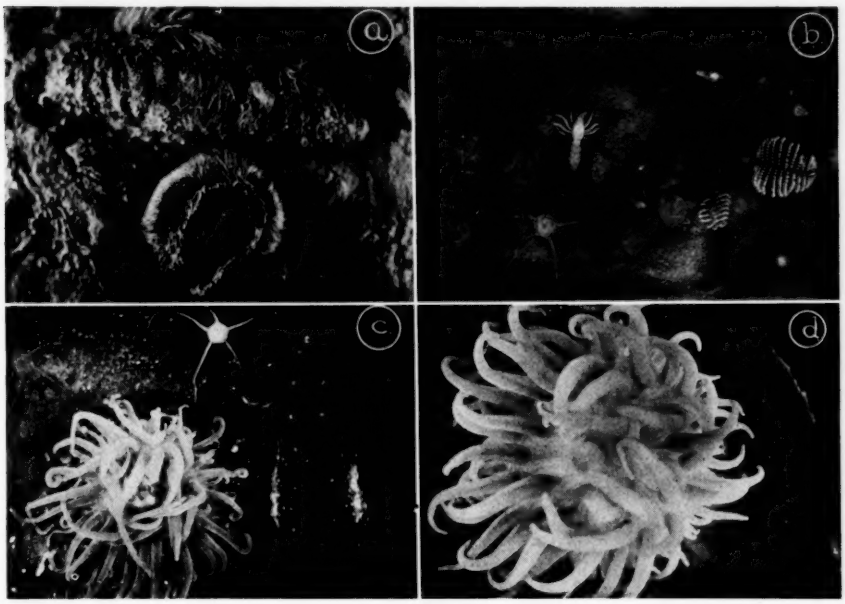

FIG. 1. a. The "sea mouse," *Aphrodite aculeata* and a sea-urchin, *Brissopsis* on clay bottom.

b. Clay bottom from a depth of about 50 meters: some ophiurans wandering over the surface; a bivalve, *Cyprina islandica*, beginning to burrow down; a sea-slug, *Cylichna cylindracea*, which showed itself at night; two phosphorescent Pennatulas; and a male and female of the blind, burrowing crustacean, *Calocaris macandreae*, the male being completely visible. On its tail are colonies of a bryozoan, *Triticella koreni*.

c. Serpent-stars, *Ophiura texturata*, and the holothurian, *Stichopus tremulus*, showing its beautiful red dorsal side dotted with white spots. The actinian, *Bolocera longicornis*, which occurs in the cold deep water of the Gullmar Fiord could not be photographed in the aquarium before December, when the water became sufficiently cold for it to thrive.

d. A fully expanded *Bolocera*. The tentacles of this actinian are usually pink or orange, but in some specimens may be a deep violet red or even white. At its side, resting on the bottom, is the holothurian *Stichopus*, its dorsal side vividly red.

a way that no shadow from the tripod or camera falls within the area of the object to be photographed. No shadows from the iron frame will disturb the picture. By arranging several lights above and on the sides

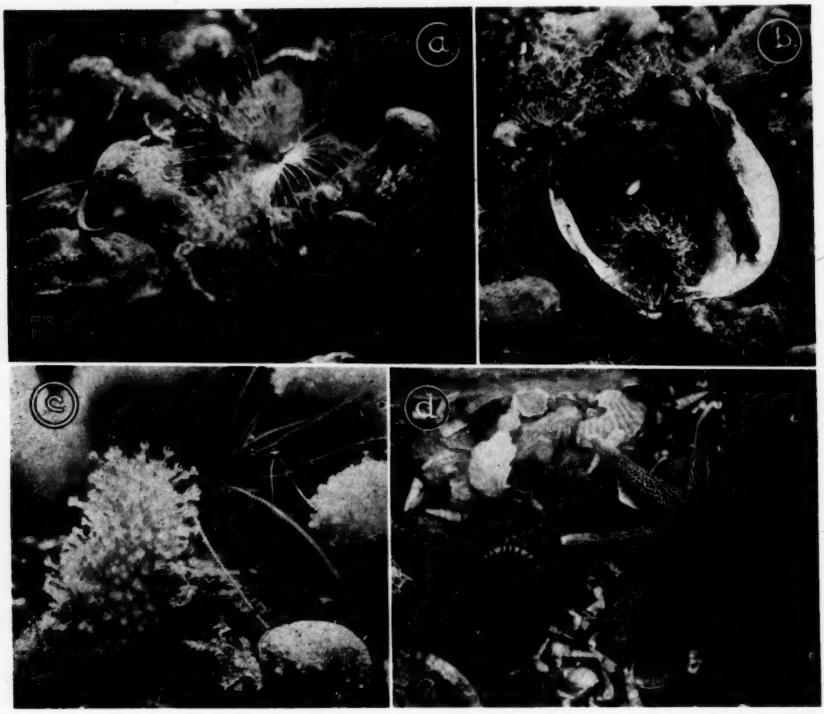

FIG. 2. a. Bottom at 30–40 meters, with ascidians, *Ascidia mentula*, *A. obliqua*, *A. virginea*, and the tube-building worm, *Sabella penicillus*, in center. Strong illumination and short exposure while the *Sabella* crown was constantly moving. The shadows are too deep, for it was impossible to get time to alter the position of the lamps which was otherwise generally done when the objects had a very uneven surface.

b. Bottom at 30-40 meters: *Cyprina* shell carrying a single *Ascidia mentula* and an actinian, *Sagartia undata*, together with a number of polychaete worms, *Dasychone dalyellii*. To the left of the polychaetes are the openings of the siphons of the ascidian, *Styela rustica*. Above this is the white sponge, *Mycale lingua*. The other lumps are *Ascidia obliqua* overgrown by bryozoa.

c. Bottom outside the Fiord at 20–30 meters, showing a colony of the bryozoan, *Alcyonium digitatum*, expanded; a shell, *Emarginula crassa*; and a barnacle, *Balanus balanus*, with the coral, *Caryophyllia smithi*, attached to its side. In the middle background are to be seen a number of branches of the hydroid, *Nemertesia antennina*, while to the lower left of the expanded *Alcyonium* there appears a small stalk of another hydroid, *Lafoëa dumosa*.

d. Shell and stone bottom on which rests a starfish, the orange colored, nine-rayed *Solaster endeca* and two actinians, *Stomphia churchiae*, with red and green spotted body and red tentacles.

of the vessel, one can easily avoid all conspicuous shadows in the aquarium. This is a most important consideration in reproducing conditions prevailing in greater depths where there is diffuse light only. Day- and sunlight, moreover, result in a heating of the aquarium water, which is not desirable. For a happy result in photographing animals occurring deeper down than in the littoral zone, it is imperative that the water temperature be kept at a low level.

One of the most important reasons for the lack of complete success in photographing by day- or by sunlight is that at such times the animals do not expand at all, or do so only very slightly. After some time in the darkness, on the other hand, they become beautifully expanded, and when in this state are very little affected by electric light. Most of our exposures of actinians, pennatulids, and other coelenterates have been made at night as much as an hour and a half after the electric light was first turned on. Once the animals were fully expanded in the dark, a gradual increase in the illumination up to the full intensity necessary for photographing in no way disturbed the splendor of their full expansion. As soon as the animals became accustomed to the full illumination, the exposure was made.

For illumination we generally used six incandescent lamps, each of 50 standard candle power, properly shaded. When photographing with the camera in horizontal position, two lamps were placed over the aquarium, one on each side of it, and two were directed obliquely towards it in front of the landscape. The two lamps last mentioned had to be placed rather near the aquarium and a little to the side so that no reflection from its glass front should appear in the camera lens. This amount of light was sufficient for photographing both stationary and slowly moving animals. In the case of more lively forms, necessitating a short exposure, the illumination has to be correspondingly increased. Fish and other rapidly moving animals were not usually photographed, as they did not, as a rule, fall within the scope of our program. When it was found necessary to include such forms in a picture, specimens killed for the purpose were placed on a suitable spot. It would no doubt be possible, however, to get a sufficiently short exposure for such objects in a living state by using more powerful lamps of perhaps 500 watts.

The camera we generally used was equipped with a Zeiss Tessar objective 1:4.5, f = 13.5 cm. In some cases a lens having a focal length of

20 cm. proved to be more suitable. Both cameras were provided with double extension bellows and were of a 9 × 12 cm. plate size.

In order to get the utmost detail, a very small stop was used, with the result that the length of exposure was considerable, from 10 seconds to as much as an hour. Only exceptionally was a half second exposure given. The plates used were rapid orthochromatic.

MOTION PICTURE TECHNIQUE IN AQUARIUM PHOTOGRAPHY*

S. C. DUNTON

New York, N. Y.

The statement, "there is nothing new under the sun," might well be applied to underwater motion picture photography. Thousands upon thousands of feet of motion picture film have been run through various types of underwater cameras by many explorers and scientists, such as Williamson, who, as is well known, is the generally acknowledged pioneer in this field, Dr. Roy Waldo Minor, Dr. William Beebe, Mr. Mac Sennett, and almost every commercial motion picture company in this country, and abroad. In short, it is a fairly standardized task to make underwater pictures.

An entirely different matter, however, is to make lifelike motion pictures of fishes exhibited in public or private aquaria. Photographic literature contains but few references to this branch of photography—in fact the writer was unable to find a single reference to aquarium cinematography—most writers dismissing even "still" work under such conditions as impractical, due to the lighting problems involved. Fishes kept in tanks or exhibition aquaria become acclimated to a certain definite environment, and accustomed to certain confines, certain temperatures, diet, lighting, et cetera. Any sudden departure from this man made environment alarms and frightens them, resulting in death or serious injury to valuable and oftentimes irreplaceable specimens.

Mr. Walter Chute, Director of the John G. Shedd Aquarium in Chicago, cites one instance where he lost a valuable collection of Walking

* From the New York Aquarium. Read at the 1934 convention of the Biological Photographic Association.

Fish (*Periothalmus*) from overheating while making a motion picture record of them. Many sad experiences of my own in earlier experiments in photographing living fish, have led to the evolution of a technique which we have adopted as a more or less standardized procedure for future underwater cinema work at the New York Aquarium.

We find there are four definite requisites for making successful motion pictures of fish. They are, briefly:

1. The specimen must be photographed in a tank to which it has become accustomed.

2. There must be adequate artificial light, so placed as to avoid reflections in the glass fronts of the tanks.

3. The specimen to be photographed should not be disturbed or excited any more than is necessary.

4. A person familiar with the individual habits of the fish should be consulted and stand by to do any handling that is required.

In considering these four points it should be noted that the proper handling of the lighting equipment and the specimens are of far more importance than the type of camera used. Any good motion picture camera is adaptable to aquarium work. A motordrive unit is preferable, for it allows the operator more freedom to follow his subjects. The film used to illustrate this paper at the 1934 Convention of the Biological Photographic Association, was made with a standard De Vry 35 mm. camera with an F. 3.5 lens of 2 inch focal length. The entire film was exposed at full aperture, using super-sensitive panchromatic stock. Repacked ends were used and proved entirely satisfactory. In discussing the four points mentioned previously, I should like to show how they apply directly to an average problem in aquarium photography.

Let us suppose that we have received an assignment to photograph some new specimens, such as the Zebra Fish (*Pterois volitans*) which have recently arrived from the West Indies. We first consult with their keeper. He tells us that these fish should make interesting subjects as they have some very unique habits, such as stalking their food (which consists of small fish) in much the same manner in which a snake stalks a bird. He further states that these specimens possess an indefatigable curiosity and are easily attracted to the surface of the water, or to the front of the tank. The tank in which they are located measures about four feet in depth, five feet in length and is about four feet in width at the top, tapering to three feet at the bottom. This is what is known as a wall tank;

that is, only the glass front (which is the only glassed side in the tank) is viewed by the public. The open top is available only by going behind the surrounding gallery wall into which this and the accompanying tanks are set.

We first set up a test light unit consisting of two photoflood lamps to find out how the fish will react. Fortunately they do not seem to mind the bright light at all. This is unusually good luck. In most instances the specimens are so alarmed by the light that it is almost impossible to do anything with them. However, we have found that if the lights are dimmed considerably, and burned from thirty minutes to one hour before shooting the scene, the fish show no great concern when the lamps are brightened to full intensity. We have to date utilized photoflood lamps in our units, and have devised a convenient plugbox which operates the lamps either in series or parallel, thus giving us two convenient light changes.[1] Our specific problem of photographing the Zebra Fish has now resolved itself into a series of five separate shots:

1. A general view of the tank with a closeup of one of the specimens.
2. A general view showing the keeper attracting the fish to the front of the tank.
3. A general view behind and above the surface of the tank.
4. A closeup of the keeper's hand and one or more of the fishes.
5. Closeups of the specimens feeding.

For the general view of the tank we utilize the light of nine photoflood lamps, or approximately 4500 watts of equivalent Mazda light. By using an aperture of F: 3.5 and super-sensitive panchromatic film, this lighting will give us a fully-exposed negative. The lamps in this case are all placed above the surface of the water. The absorptive power of water for light is tremendous. This same scene without water in the tank would require but one-third the amount of light.

Having noticed that one of the Zebra Fish usually swims in the vicinity of a large piece of tufa-rock at the bottom of the tank, we set up our camera to include that particular section and check the distance. We find that the distance from the lens to the front of the tank is two feet; from the glass front to the rock is one foot. We therefore set the lens at 2 ft. 8 in., as the refractive power of the water decreases the distance one-third. Two photoflood lamps in a reflector are placed in front of

[1] The plugbox was designed and executed by Mr. Daniel Wagner of the Aquarium staff.

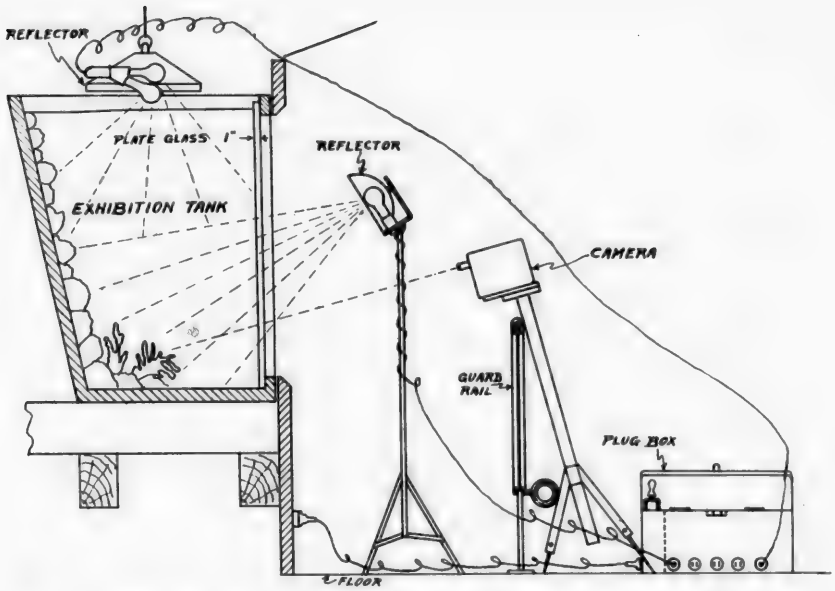

FIG. 1. SCHEMATIC DIAGRAM OF CAMERA AND LIGHTING EQUIPMENT AND ITS RELATION TO A EXHIBITION TANK

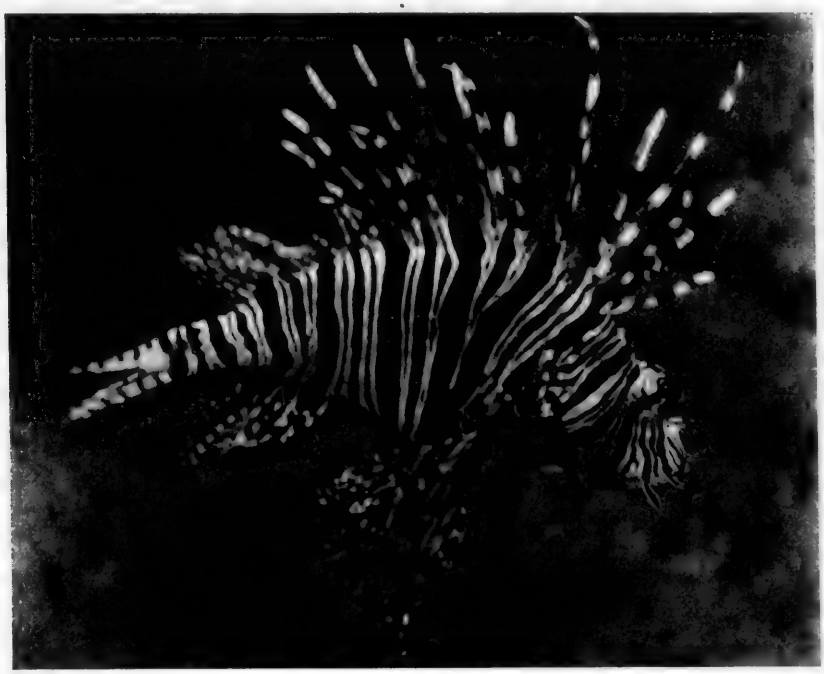

FIG. 2. ENLARGMENT FROM MOTION PICTURE FILM SHOWING ZEBRA FISH (PTEROIS VOLITANS)

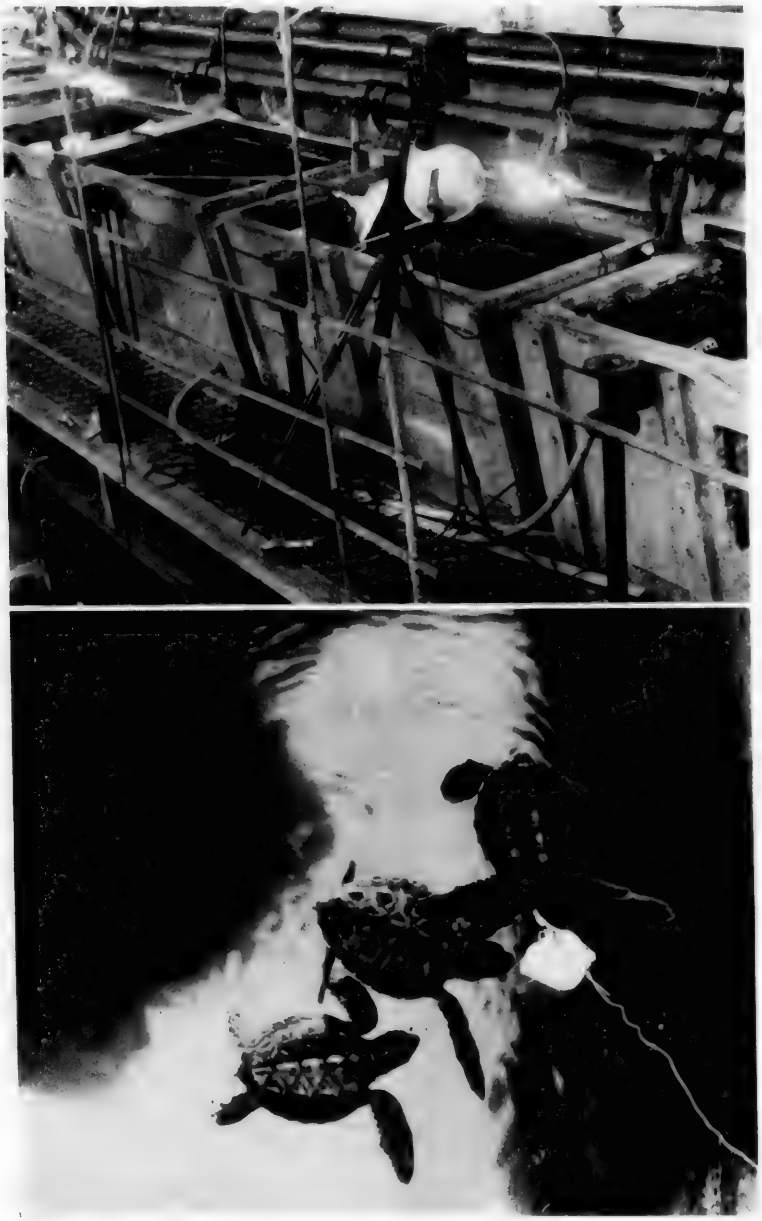

FIG. 3. THE EQUIPMENT SETUP OVER AN EXHIBITION TANK FOR PHOTOGRAPHING DOWN THROUGH THE WATER SURFACE, AND AN ILLUSTRATION OF THE RESULTS OBTAINED BY ITS USE

Note: Twice as many lamps are used outside the tank as above. These do not appear in the picture.

the glass in such a manner as to give a suitable front lighting. The placing of the lights are shown in figures 1 and 3. The lights which have been burning dimly are turned up to full intensity, and the shot is made.

The same setup is used for the shot of the keeper attracting the specimens to the front of the tank, except that two more photofloods are added to illuminate the keeper's hand. Great care must be exercised to keep the reflections of these lights out of the glass front. Scene No. 5 (the specimens feeding) is shot third, in order to utilize the present lighting setup which is the same except that only top lighting is used. Some live Killifish (*Fundulus*) are placed in a corked test tube and floated in the tank. As the Zebra Fish attempt to strike at them through the glass, the action is filmed, making a most effective scene. The remaining scenes (all back of the tank) are made at least two days later when the fish are again interested and hungry enough to respond.

In all instances where a scene is photographed through the surface, at least two-thirds of the light is used from outside the glass front of the tank, giving a lighting that is subsurface in effect (fig. 3).

In conclusion, therefore, we find that it is possible to make acceptable motion picture records of living fish in aquaria, provided the operator is willing to take the necessary time to study the habits of his subjects, and is willing to arrange his lights and equipment in such a manner that the fish are subjected to no greater excitement or alarm than that which is caused by a casual observer looking into the tank.

In almost every instance where successful motion pictures of aquarium fish have been made, one will find upon examination that the specimens have been photographed in their own tank, and natural or artificial light utilized in such a manner that the specimens were oblivious to its presence.

PHOTOMICROGRAPHY IN THE ULTRA VIOLET

L. V. FOSTER*

Rochester, N. Y.

It is well known that the resolving power of a microscope depends upon the wave length of light employed and the numerical aperture of the objective. Abbé has pointed out many years ago that the resolving power of the microscope is $\frac{\lambda}{\text{N. A.}}$, where lambda represents the wave length of the light used, and N. A. represents the numerical aperture of the objective.[1, 2] To satisfy this condition a narrow pencil of light may be used to illuminate the object, that is, the iris diaphragm of the substage condenser may be closed to a small aperture allowing a central pencil of light to pass through the object and on through the microscope objective. The finest details in the object which can be seen will then be no smaller than $\frac{\lambda}{\text{N. A.}}$ It is easy to see that as lambda becomes smaller, the details in the object, which may be seen with a given microscope, will become smaller; also as N. A. becomes larger the details in the object which may be seen will become smaller.

The Ultra Violet Microscope was developed in 1900 for biological research, but has not been extensively used.[3] This microscope was one which used a wave length of about 2750 Å. This wave length is in the short ultra violet range and is not transmitted by glass. The materials used for lenses in this microscope had to be fused quartz, fluorite or other crystals transparent to the short wave length. Furthermore, the objects had to be mounted on quartz slides and covered with fused quartz cover glasses. Any mounting material, such as cement, had to be a material

* Scientific Bureau, Bausch & Lomb Optical Co., Rochester, N. Y. Received for publication February 22, 1935.

[1] "A Contribution to the Theory of the Microscope, and the Nature of Microscope Vision," by Dr. E. Abbé, Schultze's Archive fur Mikroscopische Anatomie, Vol. 9. This has been translated by H. E. Fripp and published in the Proceedings of the Bristol Naturalists' Society new series, Vol. I, Part II.

[2] "On the Limits of the Optical Capacity of the Microscope," by Prof. Helmholtz. Proceedings of the Bristol Naturalists Society, Vol. I, Part III.

[3] It was described by Dr. August Köhler in an article "Photomicrography investigation with ultra-violet light," Zeitschrift fur wissenschaftliche Mikroskopie, Band XXI, 1904.

transparent to wave lengths around 2750 Å. Fused quartz and fluorite was used in making the microscope objectives and they could not be achromatized. The objectives were, therefore, called monochromats and were corrected spherically for only one wave length of the spectrum. The eyepieces were made from crystalline quartz. No filters existed which would cut out all of the visual spectrum and pass only one wave length of the ultra violet. Therefore, in order to illuminate the object with only one wave length of light, the spectrum of the source had to be dispersed by a quartz prism and all wave lengths, except that for which the objectives were corrected, stopped from reaching the object. Such an illuminating system is called a *monochromator* and when it is made for transmitting ultra violet radiations, it is a *quartz monochromator*. The quartz monochromator has to be adjusted, so that only the wave length selected for photography will pass the exit slit of the instrument. The source of light selected for this work was the cadmium spark since it had a very strong line at 2750 Å. In order to make photographs, one must use visible light for focusing, and then return to the cadmium spark and compensate for the difference in focus between the visual and ultra violet. Close approximation to the true focus could be had by the use of a fluorescent eyepiece. This eyepiece was substituted for the quartz eyepiece and contained in its focal plane a piece of uranium glass which fluoresced strongly in ultra violet, making it possible to see the outlines of a specimen but not its details. Several test exposures had to be made, varying the focus each time to arrive finally at the correct focus. This equipment was costly, to say the least, and very complicated and time-consuming to operate.

About 1929 Mr. Trivelli of the Eastman Kodak Research Laboratory discussed with the writer the possibility of correcting our regular microscope objectives for two wave lengths, one in the visual and one in the near ultra violet. The wave lengths chosen were those of two prominent lines in the quartz mercury arc spectrum, the one in the visual being 5460 Å and the other in the ultra violet being 3650 Å. These were selected because they could be isolated by existing colored glass filters. It seemed quite possible at the time Mr. Trivelli spoke to me about this to correct some lenses so. The first attempt was made on a 16 mm. micro objective. It was corrected for these two wave lengths, so that the rays for 5460 Å and 3650 Å were superimposed upon each other; the idea being that if the two wave lengths, one in the visual spectrum and one

in the ultra violet spectrum, were corrected together, one would be able to focus visually by use of a filter in the visual region and then photograph by use of another filter in the ultra violet region: that is, since the objectives would be achromatized for these two wave lengths the image would be as sharp in focus in one wave length as in the other wave length. In other words, if the object has been focused in green light, it must also be focused in ultra violet light of the particular wave length which was used in its correction. The first attempt was indeed very successful. The 16 mm. objective was tried out by Mr. Trivelli on several specimens and he focused in green light, using a quartz mercury arc lamp and a Wratten No. 62 filter, and photographed in ultra violet light, using a Wratten filter No. 18 A which passed 3650 Å. The photograph was in excellent focus, and the detail apparent in the photograph was much better than that apparent in the photograph made in green light. Since the 16 mm. objective was so successful and since the resolving power of an oil immersion objective is not all that one would like it to be, it was decided to correct an oil immersion objective for these two wave lengths and see if similar improvement in resolution could be obtained. Naturally, the resolving power was greatly increased. Another difference which became apparent in the tests conducted with these first few objectives was that of absorption. The dyes used in staining objects have selective color absorption and a great many of these dyes have stronger absorption in the ultra violet than in the visible.[4] It was found out that many details were brought out in the pictures taken in the ultra violet light due to selective absorption, which were entirely obscured in the green light.

The quartz mercury arc adapted by us as a light source is made by the General Electric Mercury Vapor Lamp Company in Hoboken, N. J. They make two lamps of practically the same intensity, one which operates from direct current and the other from alternating current. It is a burner about 6″ long and about 1″ in diameter. The alternating current lamp is Y shaped and operates from a transformer with a split winding. The mercury pool at the bottom of the lamp is the negative terminal and the two top terminals of the lamp are both positive. The bottom or negative terminal connects to the center top of the split winding of the transformer, and the two positive terminals connect to the two ends of the windings. These two poles are alternately positive with

[4] Photo-micrography with the 365 μ Mercury Arc Line by A. P. H. Trivelli and L. V. Foster, Journal of the Optical Society of America, Vol. 21, No. 2, February, 1931.

respect to the center top, so that the arc stream alternates from one side of the Y to the other at the frequency of the A. C. supply (usually 60 cycles). Heavy choke coils in the positive leads causes a lag in the voltage change during the cycle. This action sustains the arc during the time when the line voltage passes through zero. The result is a steady arc stream through the short arc tube between the coils and the mercury pool, producing light of the same intensity as the D. C. lamp. The life of the lamps ordinarily amounts to several thousand hours. Both the D. C. lamp and the A. C. lamp have to be run about three minutes before reaching a maximum intensity. The lamphouse containing either lamp is designed to fit on any standard lamp support and condenser; that is, this lamphouse can be put on any photo-micrographic apparatus equipped with a Bausch and Lomb arc lamp, a ribbon filament lamp or coil filament lamp.

Figure 1-A shows the spectrum of the quartz mercury arc. Fixing our attention on the region from 3000 to 6000 Å, we see a line at about 3340, others at 3650, 3660, 3900, 4040, 4070, 4360, 5460 and 5800. The idea in this work was to make use of the line at 5460 for focusing in the visual spectrum and the triplet at 3650 for photography in the ultra violet. Figure 1-B shows the transmission in terms of density of the No. 62 Wratten filter. Note that the strong 5800 mercury line is entirely cut out by the filter which permits the transmission only of the 5460 line. Figure 1-C shows the transmission in terms of density of the UV filter. Note that the density at 3000 Å is 2.4 and at 4000 Å is 3.0. This is sufficient density to cut out the lines 3340, 3900, 4040, 4070, 4360, etc. The maximum transmission of this filter is at 3600, while at 3650 the transmission is about 40%.

Figure 2A shows the transmission curve in terms of density of the 16 mm. objective, together with the UV filter. The objective and filter transmit 28.2% of the intensity of the triplet 3650 Å, and only 4.5% of the weak line 3900 Å. The intensity of this line is so weak that it will have no effect on a photographic plate which has been only sufficiently exposed for the 3650 Å triplet.

Figure 2B shows the transmission curve in terms of density of the 6 mm. UV objective and the UV filter. The objective cuts out everything below 3500 Å with the result that the objective and filter transmit 15.5% of the intensity of the triplet 3650 Å and only 1.6% of the weak line 3900 Å.

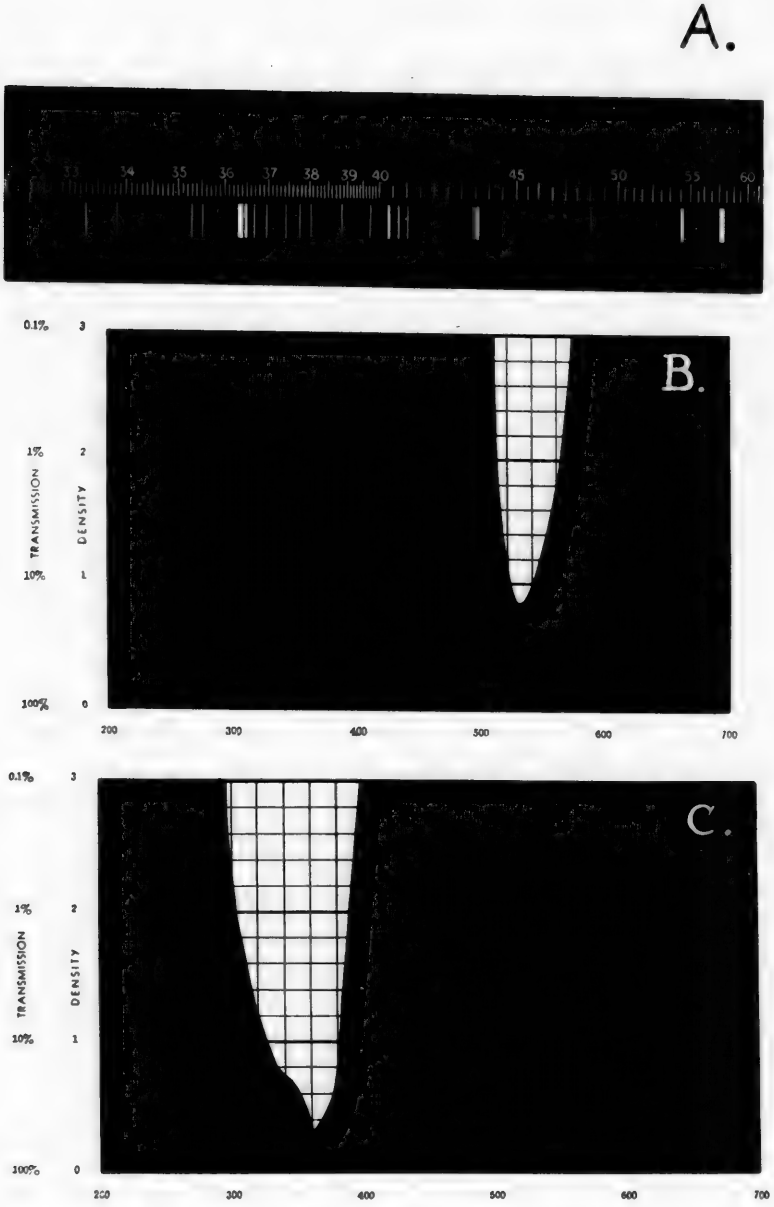

FIG. 1.

A: Spectrum of quartz mercury arc lamp. Made with Bausch & Lomb medium quartz spectrograph. Slit width 5 microns—Aperture f:11.0. Shows the strong triplet at 3650 Å and only relatively weak lines at 3900 Å, 4040 Å and 4070 Å. 3340 Å line is partially passed by this filter.

B: Transmission in terms of density of the No. 62 Wratten Filter. Note that the strong 5770 Å line is entirely cut out by the filter which permits the transmission only of the 5460 Å line.

C: Transmission in terms of density of the UV Filter. Note the density at 3000 Å is 2.4 and at 4000 Å is 3.0. This is sufficient density to cut out the lines 4040 Å and 4070 Å.

Figure 2C shows the transmission curve in terms of density of the 1.7 mm. objective and the UV filter. As in the other cases, this objective cuts out everything below 3500 Å with the result that the objective and filter transmit 21.9% of the intensity of the 3650 Å.

Now let us go back to the formula for resolution. This expresses the size of an object that can be seen with central illumination. If we now make use of oblique illumination by means of a small pencil, the resolving power is doubled or is expressed by $\frac{\lambda}{2\,\text{N. A.}}$. In order to realize this condition it is necessary to pass to the very edge of the aperture of a microscope objective a small pencil of light. This can be done by closing the iris diaphragm of the substage condenser and decentering it sufficiently to cause the illuminating pencil to pass through the objective at its periphery. If the objective is one having numerical aperture higher than 1.00, the slide must be connected with the substage condenser by an immersion liquid. The theoretical limit of resolving power for an objective of N. A. = 1.40 is for a wave length 4500 Å. which is the extreme visual blue equal to 0.16 μ; and for an objective of the same numerical aperture, but of a wave length 3650 Å = 0.13 μ. With an objective of N. A. 1.30, for a wave length of 3650 Å, the resolving power would be equal to 0.14 μ, while the ultra violet photo-micrographic outfit using 2750 Å as a source of light and with an objective of N. A. = 1.25, the maximum resolution is equal to 0.11 μ. N. A. 1.25 is used here because that was the maximum numerical aperture for which the monochromatic objectives could be corrected. This means that with an objective of N. A. = 1.40, photo-micrography with the 3650 Å mercury line is able, theoretically, to give 19% more resolving power than the best microscopic system using a Wratten blue filter. An objective of N. A. 1.30 corrected for a wave length of 3650 Å will have 12.5 % more resolving power than an objective using the same numerical aperture and the extreme visual blue light. The one exception is the monobromnaphthalene immersion objective of N. A. = 1.6, which, with 4500 Å gives a resolution of 0.14 μ —slightly less than could be obtained with an objective of N. A. = 1.30, using the 3650 Å wave length. These objectives are, however, very rarely used for resolution work, but have their practical applicability in the measurement of the angles of biaxial crystals. This is because the high numerical aperture of them is more than can be spherically corrected in existing microscope objectives, and their definition, therefore, at high aperture, is not good enough for resolution.

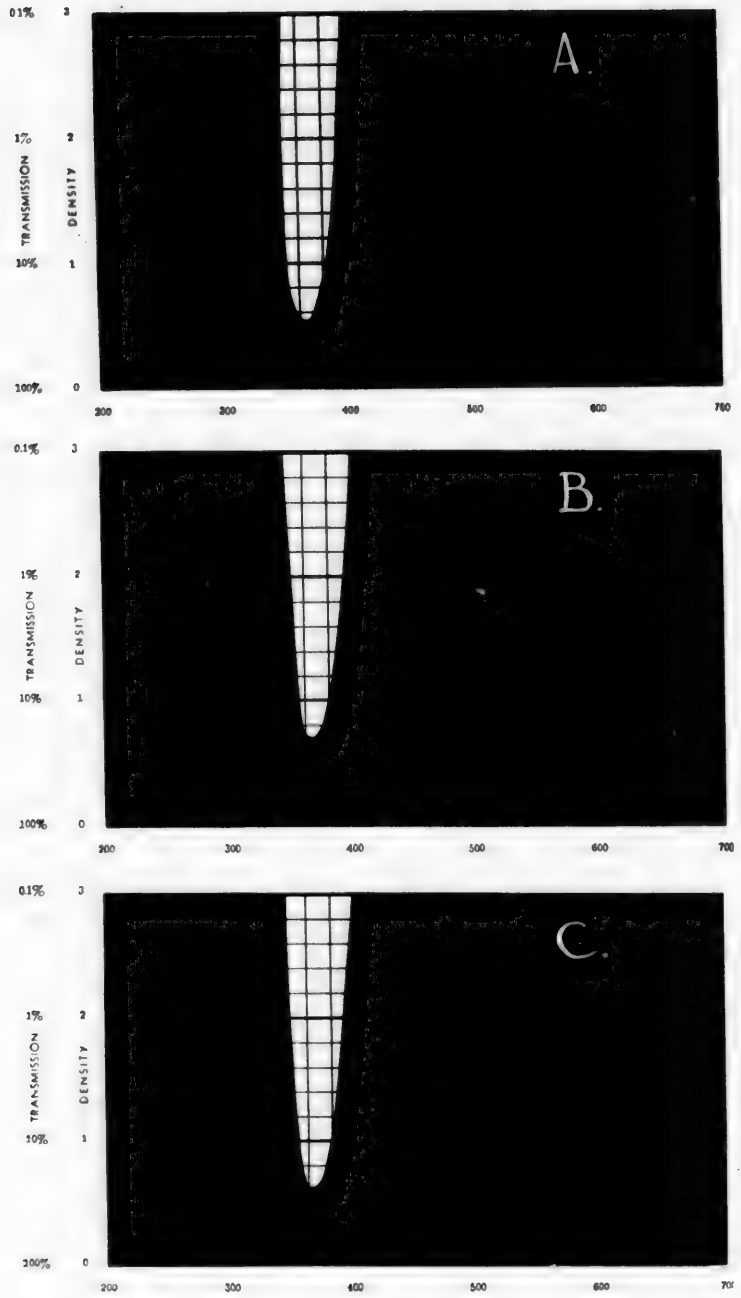

FIG. 2.

A: Transmission curve in terms of density of the 16 mm. UV Objective and the UV Filter. The objective and filter transmit 28.2% of the intensity of the triplet 3650 Å and only 4.5% of the weak line 3900 Å. The intensity of this line is so weak that it will have no effect on a photographic plate which has been only sufficiently exposed for the 3650 Å triplet.

The method of illumination for photomicrography in 3650 Å is substantially the same as in photomicrography in the visual spectrum. The conventional substage condenser and condenser at the lamphouse are entirely satisfactory for this work. However, in many cases exposures can be substantially reduced by using a quartz condenser at the lamphouse and a quartz substage condenser in place of the conventional Abbé condenser. The light source, namely the arc, is focused by means of the lamphouse condenser in the plane of the substage condenser and the substage condenser is adjusted to focus the lamphouse condenser in the plane of the object. The filters may be placed either directly back of the substage condenser or in front of the condenser at the lamphouse.

It is to be understood that 3650 Å is quite largely transmitted by almost all ordinary glasses. Therefore, conventional eyepieces are entirely satisfactory for making pictures with objectives corrected for 3650 Å. The exposures used to make the pictures illustrated here have varied from 2 seconds up to about 15 minutes. All of the pictures in ultra-violet have been made on process plates. The others were made on metallographic plates. The variation in exposure usually comes from the thickness of the specimen and the mounting medium used in preparing the slide. It should be pointed out that if one is making slides expecially for photography in the ultra-violet, one should avoid Canada balsam as a mounting medium because this material is more opaque in the ultra-violet light than some of the other mounting mediums such as damar, glycerine and water. In using oil immersion objectives, it is advisable to use only sandalwood oil since this material is far more transparent at 3650 Å than the usual cedarwood oil. The only other precaution necessary is that the cover glass have a thickness of 0.18 mm. While the objectives are immersion objectives, they are not strictly homogeneous since the dispersion for glass is quite unlike the dispersion for saldalwood oil between the wavelengths 5460 and 3650.

B: Transmission curve in terms of density of the 6 mm. UV Objective and the UV Filter. The objective cuts out everything below 3500 Å, with the result that the objective and filter transmit 15.5% of the intensity of the triplet 3650 Å and only 1.6% of the weak line 3900 Å. The intensity of this line is so weak that it will have no effect on a photographic plate which has been exposed for the 3650 Å triplet.

C: Transmission curve in terms of density of the 1.7 mm. UV Objective and the UV Filter. The objective cuts out everything below 3500 Å, with the result that the objective and filter transmit 21.9% of the intensity of the triplet 3650 Å and only 2% of the weak line 3900 Å. The intensity of this line is so weak that it will have no effect on a photographic plate which has been exposed for the 3650 Å triplet.

Figures 3 and 4 show under A, pictures made in wave length 5460 Å and under B, the same field made in wave length 3650 Å. These pictures show besides increased resolution obtained in ultra-violet light, the dif-

FIG. 3

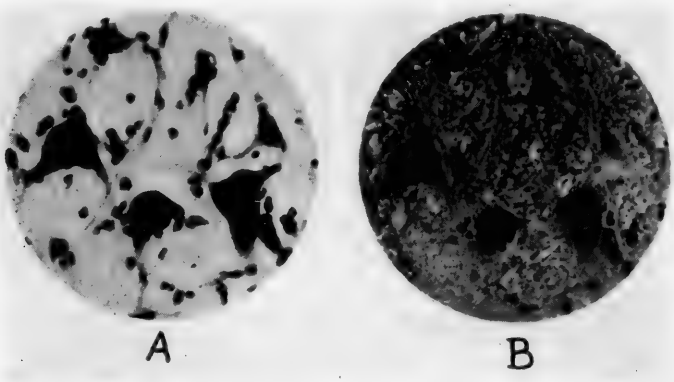

FIG. 4

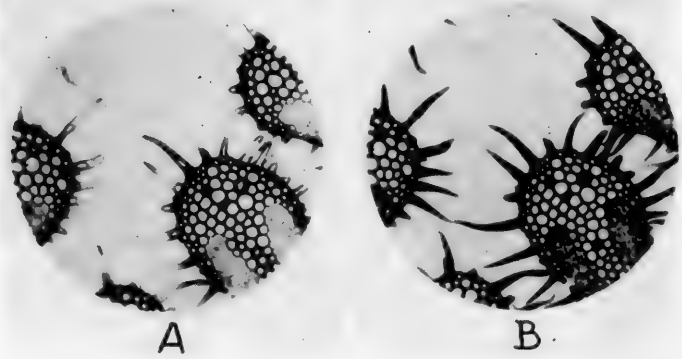

FIG. 3. SECTION OF BRAIN

6 mm. 0.65 N. A. objective and 10× Huygens Eyepiece. Magnification 500 ×.
A: Photographed in wave length 5460 Å.
B: Photographed in wave length 3650 Å.

FIG. 4. AMMOPHELIA LEAF C. S.

16 mm. 0.25 N. A. objective and 7.5× Hyperplane Eyepiece. Magnification 64 ×.
A: Photographed in wave length 5460 Å.
B: Photographed in wave length 3650 Å.

ference in absorption of the specimen for these two different wave lengths.

Figure 5 shows under A, a picture made in wave length 5460 Å under

B, the same field made in wave length 3650 Å. The latter was made to show the increase in resolving power obtained in ultra-violet. This can be appreciated by noting the finer rendition of the spirochaete.

FIG. 5

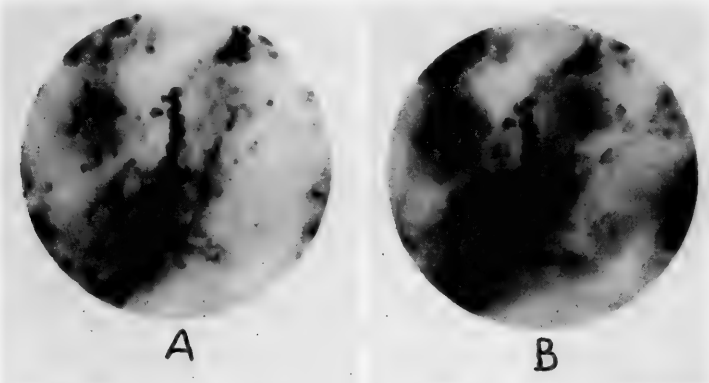

FIG. 6

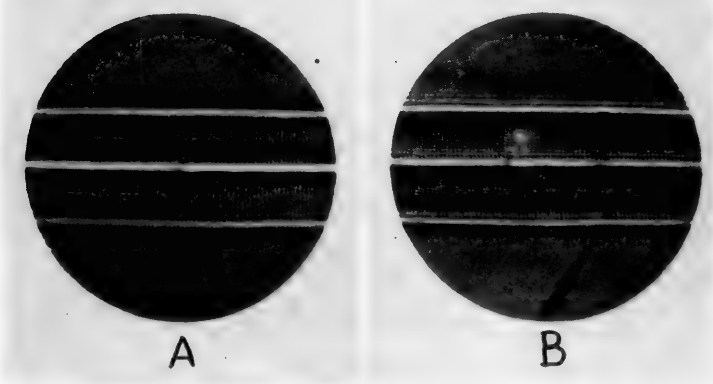

FIG. 5. SPIROCHAETA PALLIDA

1.7 mm. 1.30 N. A. 10× Hyperplane Eyepiece. Magnification 2000 ×.
A: Photographed in wave length 5460 Å.
B. Photographed in wave length 3650 Å.

FIG. 6. AMPLIPLEURA PELUCIDA

1.7 mm. 1.30 N. A. objective. 10× Hyperplane Eyepiece. Magnification 2000 ×.
A: Photographed in wave length 5460 Å.
B: Photographed in wave length 3650 Å.

Figure 6 shows under A, a picture made in wave length 5460 Å, and under B, the same field made in wave length 3650 Å. This picture of *Amplipleura pelucida* was taken to show increased resolving power obtained in ultra-violet.

PHOTOGRAPHY OF LIVING TISSUE IN SITU*

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The method described here was primarily designed for photographic recording of intracellular processes in the living, intact thyroid gland of certain salamanders. As it seems probable that the procedure is adaptable to other structures in different organisms, this particular method is described for its more general usefulness.

The essential procedure consists in the use of light which is transmitted to the thyroid gland by means of a quartz rod. Quartz, unlike glass, will transmit light uniformly around a curved surface (qr. of fig. 1-C). The rod is, therefore, bent so that the light is conducted from the light source to the under (dorsal) surface of the gland. It is then transmitted through the gland and into the objective of the microscope.

In the intact thyroid gland the blood flow obscures the field and prevents clear observation and photography. We have found, however, that an anemia localized to the field may be produced by moderate pressure of part of a microscopic cover-glass on the upper surface of the gland (cg. of fig. 1-C). Since the pressure must be controlled rather delicately, the cover-glass, which is mounted on the end of a long glass rod, is manipulated by a micro-manipulator (Chamber's Instrument). The position of the quartz rod is also conveniently controlled by a second micro-manipulator (mm. of fig. 1-A). By this arrangement the gland is gently pressed between the flat upturned end of the quartz rod and the cover-glass. The relative position of the quartz rod and the cover-glass, and micro-manipulator are shown in figures 1-A and 1-C. As the cover-glass is slowly brought down on the spheroid surface of the gland a point is reached where the pressure suffices to close the capillaries in the center of the field while allowing the general circulation through the gland to continue. Releasing the pressure reëstablishes circulation.

The animals used in these studies (Triturus torosus) are anesthetized by intra-peritoneal injections of "Nembutal." The thyroids are exposed from the ventral side under Ringer's solution, using a dissecting binocular microscope, and the overlying connective tissue is stripped away. The

* From the Department of Anatomy, University of Maryland School of Medicine
Received for publication, June 24, 1935.
† Aided by the Weaver Fellowship Fund.

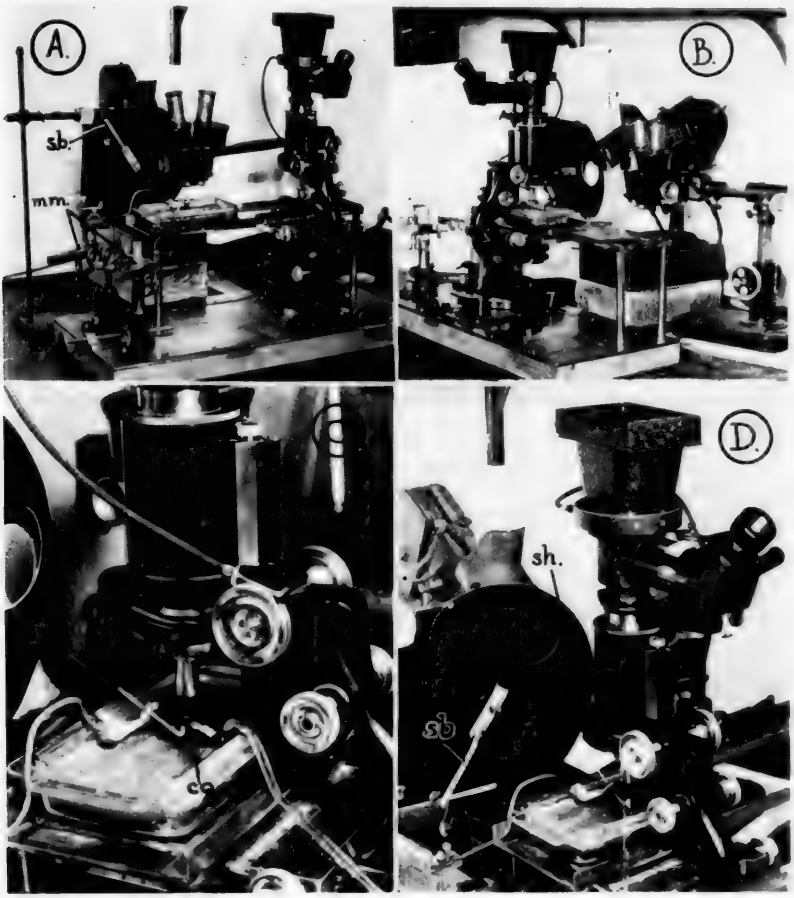

FIG. 1. APPARATUS FOR PHOTOGRAPHY OF LIVING INTACT THYROID GLANDS OF SALAMANDERS

A. General arrangement of apparatus with dissecting microscope in place. mm.—micro-manipulators; sb.—shutter bar.

B. General arrangement of apparatus with compound microscope in place.

C. Showing relative position of the quartz rod and cover-glass. qr.—quartz rod; cg.—cover-glass.

D. Showing shutter arrangement. sh.—shutter; sb.—shutter bar.

quartz rod and cover-glass are then brought into place. The general arrangement of the apparatus may be seen in figure 1-A. The binocular microscope is then replaced by a compound microscope, carrying the camera, a Zeiss "Phoku" eye-piece. (Fig. 1-B and D.) The compound microscope is carried on a mechanical stage running in a track attached to the base plate. By this arrangement the compound microscope is easily slid into position as shown in figure 1-B.

As it is impracticable to move the field, the latter is explored by the movement of the microscope by means of the mechanical stage on which it rests. This stage is best shown in figures 1-A and 1-B. It consists of two rectangular brass plates. The upper one carries the microscope and allows motion to and from the observer. The lower plate gives motion to the right and left by means of the detachable screw shown on the left in figure 1-A.

An arc lamp, carrying a condensing lens, is used as a light source. A Wratten heat absorbing glass has been incorporated in the light beam from this lamp to prevent over heating of the tissue when studying the gland. Due to the fact that this cooling cell reduces the intensity of the light it is removed during the short interval of exposure thereby making long exposures unnecessary.

The improvised shutter, as seen in figure 1-D allows the hot beam (without the cooling cell) to be on the gland only for the time the plate is being exposed. This exposure can be regulated from approximately $\frac{1}{25}$ to 1 second by changing the position of the counter weights on the shutter bar. (sb. in fig. 1-A and D.) In figure 1-A the shutter is shown after the exposure is completed. Figure 1-B shows the shutter open, and figure 1-D shows the shutter in position for exposure.

The photographs of these living thyroids were obtained with a number 40 Zeiss water immersion objective on process panchromatic plates. These plates were chosen because of their speed and contrast; two essentials in the photomicrography of living, unstained tissue in situ.

Further studies are now being made by the author on the intracellular processes of the thyroid, with the help of vital dyes, and the use of the thyreo-activator in stimulation of colloid release.

NEW APPARATUS FOR MACROPHOTOGRAPHY*

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In the December, 1933, issue of the Journal of the Biological Photographic Association, I wrote an article on various apparatus for macrophotography (1). Since the publication of this article three other equipments have been brought to my attention which I consider worthy of description, as a continuation of my previous article on the same subject.

The first of these camera stand apparatus was described in the June, 1935, issue of *Popular Mechanics* by W. J. Reed (2). Accompanying this author's article were three of the illustrations herewith reproduced. He writes as follows:

In my daily use of the well-known type of three-castered camera stand, with which so many photographic studios are equipped, I made a few improvements that greatly increased its utility to meet modern requirements.

The stand originally was made to permit a camera height of 4 ft., but by adding extensions on the two parallel uprights, a full range of adjustment up to 9 ft. was obtained. To do this, first remove all devices under the camera bed except the shaft with gears, which is attached to the hand wheel. Then attach two thin steel plates, drilled for six screws, to the sliding frame to make it more rigid. To lengthen the upright, have two pieces of wood grooved and trimmed to the same size as the uprights. You can make these extension pieces any required length; 40-in. pieces will give a range of height up to 7½ ft. They are attached with 14-in. lengths of 2 by 2-in. angle iron, drilled for bolts as shown in the detail. When attaching the extensions, remove the caps from the old uprights. These can be used to finish off the new ones. Two racks with which the gears engage, are purchased from a supply house. These should be just as long as the extensions, and must be mounted carefully so that the gears will track easily. Strips of paper may be used to shim the racks at points where the surface of the wood varies. To increase the rigidity of the extension pieces, flat-iron braces are attached with thumbscrews.

To turn the camera in a vertical position for photographing objects on the floor, you can make a tilting attachment. It consists of a piece of ½-in. iron rod bent to a semi-circle having a 10-in. radius. The ends are fitted with flanges to facilitate attachment to the bed of the camera stand. To hold the camera at any desired angle, notches, spaced ¼ in. apart, are filed in the rod as indicated, and a stationary finger, under spring pressure, is arranged on a cross piece to fit the notches. The finger is a steel rod ground or filed to an edge to fit the notches. It is held in a piece of pipe cut as shown, with the ends bent at right angles and drilled for screws, with which it is attached to a crosspiece located just below the notched rod. A small coil spring

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Received for Publication June 29, 1935.

retained by a pin, forces the finger against the rod. A length of wire is attached to the top of the finger and is carried over two small pulleys to a handle. When this is pulled, it lifts the finger and allows the camera to be tilted.

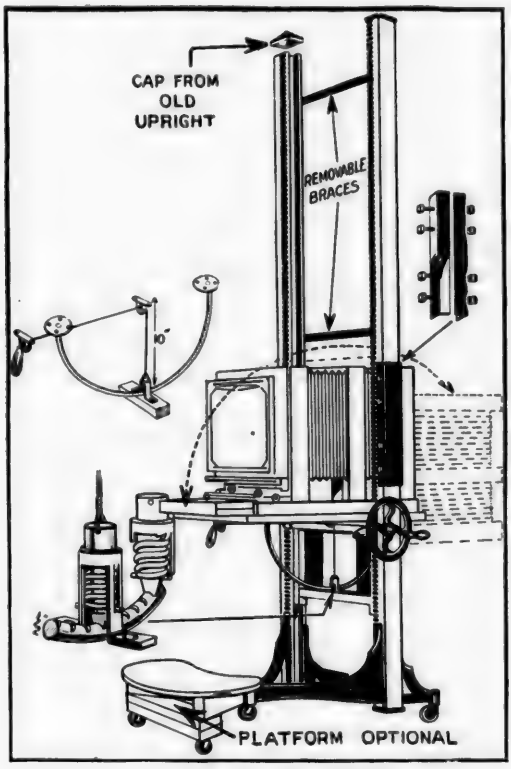
Courtesy Popular Mechanics Magazine

FIG. 1

The description of the second apparatus, as seen in figure 4, was written by Mr. V. Covert Martin (3), and published in the May, 1935, issue of *The Commercial Photographer*. This author has the following to say about his apparatus:

This overhead camera cost us $3.60 as we had most of the necessary materials, such as wire, sockets, paint, etc., around the plant. It works on a sliding track so

it can be elevated from two to eight feet above the plate glass. This is illuminated underneath, to eliminate the necessity for later blocking-out on negatives. Reflectors on the camera-carrier throw the light directly downward, and are made from old carbonate cans. The handle, bar and brackets for raising and lowering were taken from a discarded flash cabinet. The uses of an overhead camera, especially in the



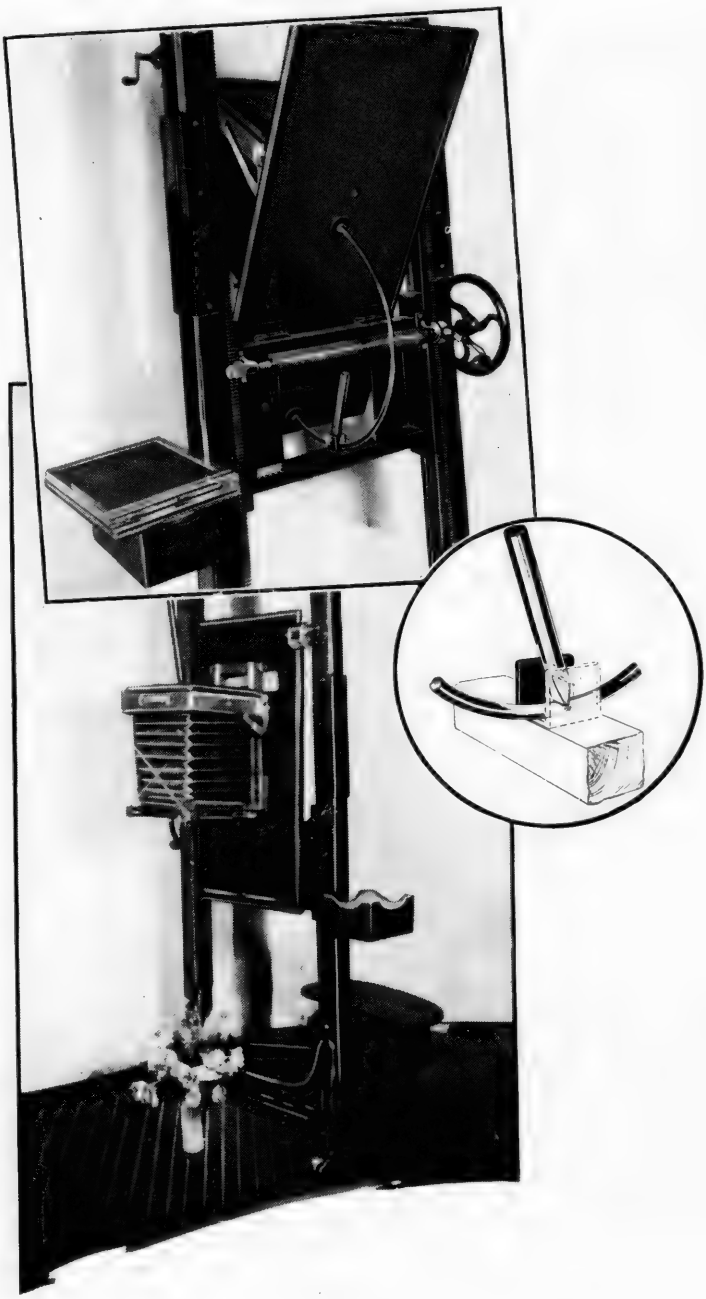
Courtesy Popular Mechanics Magazine

FIG. 2

photographing of small parts, are so many that such a piece of apparatus cannot properly be appreciated until you have one.

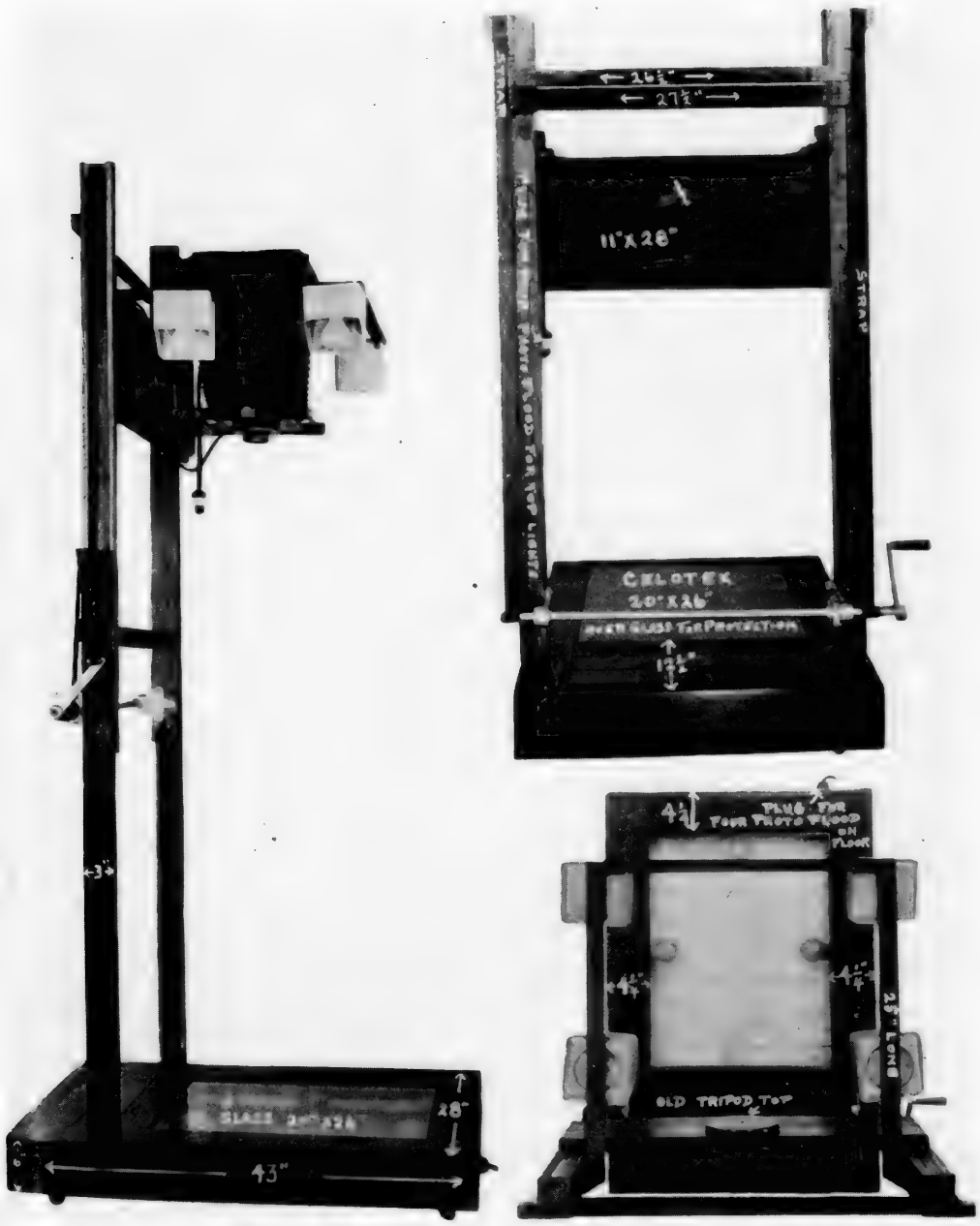
The third of these apparatus, as seen in figure 4-A and B, was developed by myself in the Department of Art at the University of Maryland. Figure 4-A is a front view, and 4-B is a side view of this apparatus. The lower case identification letters are the same in both views.

I believe that this equipment has a greater range of application. The camera can be moved up and down, and is counterbalanced by weights,



Courtesy Popular Mechanics Magazine

FIG. 3



Courtesy The Idea Exchange in The Commercial Photographer

FIG. 4

(i), for easy manipulation. It can also be operated at any angle between vertical and horizontal. The camera is fastened to the base by a camera screw in general use. This enables various sized cameras to be used

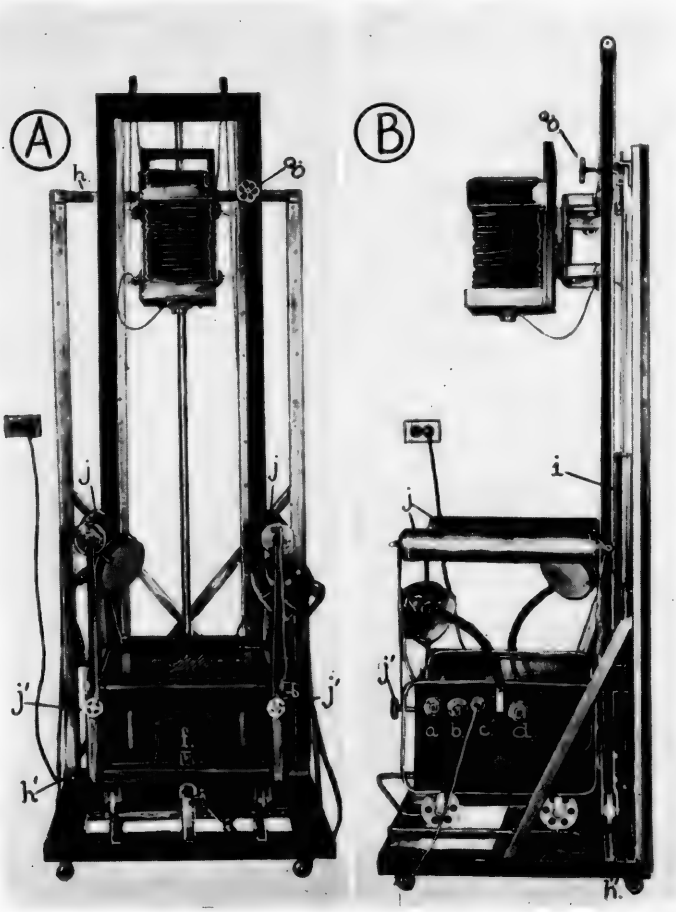


FIG. 5

on the stand. The entire upright framework supporting the camera can be moved to the right and left, and travels on the tracks "h," and "h'." It can be locked in place by the hand screw, "g."

In considering the lightbox beneath the camera, it may be said that

this box can be moved forwards and backwards for about six inches, and can be locked in a stationary position by the hand screw at "k." There are three systems of lights. The first are ordinary copying lights (j), which can be placed at any desired angle to the copy, and locked by the hand screws "j'." These screws are on axles that lock the supports both in front and in back. The copying lights consist of four 100 watt frosted bulbs. They are controlled by the switch at "a," shown on the side view. "C" represents the current supply. Photographs of copy as large as 17″ x 20″ can be made on this stand.

The second lighting system consists of two 100 watt frosted bulbs, in reflectors mounted on goose neck supports. In front of these bulbs are discs of flashed opal glass. These lights are used for the lighting of small objects, such as pathological specimens. The opal glass reduces the tendency towards pin-point highlights so common in photographs of wet specimens. They also produce shadows that are not sharp but graded in tone. The control switch is shown at "b" in the side view. Should a white background be desired, the lights within the box (controlled by the switch at "d") can be turned on. These lights are beneath two sheets of tracing cloth, giving perfectly even illumination to two pieces of glass in the top of the box. These glasses measure 14″ x 17″ in size. Any negative up to the large radiographic negatives can be mounted between them for reducing or enlarging into the camera. The tracing cloth mentioned above has been mounted on window shade rollers within the box. This facilitates easy cleaning and removal through the door of the box, which opens by a clasp at "f."

The entire apparatus is mounted on casters, and may be moved about the room. It has been finished in black enamel, with chromium plating on all metal parts. This finish lends itself to the modernistic design we are attempting to carry out in the equipment of our laboratory.

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THE PHOTOGRAPHIC LENS AND ITS APPLICATION TO BIOLOGICAL PHOTOGRAPHY

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In order to specify a certain type of lens as suitable for any particular purpose it is necessary to have a few general rules to follow. Otherwise one would get lost among the great number of different kinds, speeds and sizes of photographic objectives that are on the market today. It will be convenient to consider first the material from which lenses are made, then the process of designing a lens system to meet a given set of conditions, and last the workmanship that is necessary to attain satisfactory performance. Each of these subjects is such a large one that a mere outline of them is all that can be attempted here; but even an outline will be found to uncover many facts that are helpful in the choice of an objective for a definite job of photography.

The photographic lens is a precise optical instrument; so optical glass is the material from which its elements must be made. Optical glass differs from ordinary glass in many ways. It is free from color, has a high transmission throughout the whole spectrum, and is homogeneous in the optical sense; that is, it has the same index of refraction throughout the entire piece. This means that it is free from any imperfections of structure that can bend light rays out of their proper path. The condition is somewhat like the difference between plate glass and cast window glass. One can see clearly through plate glass because light comes through it undistorted by the substance or structure of the material. If the edges of plate glass are polished, however, and one tries to look through it edgewise, he will find it full of wavy lines that distort the scene that is being observed. Optical glass is free from this defect in all directions. The structure of the material is uniform throughout the whole piece.

The second important property of optical glass is that it can be annealed by careful heat treatment to be free from inward strain. This is a very necessary preliminary to the manufacture of good lenses for any purpose. Each surface of a lens must be ground and polished to an exact radius, and the material must hold its form precisely during these operations and not spring out of shape after they are completed.

* Scientific Bureau, Bausch and Lomb Optical Company. Received for publication April 2, 1935.

In addition to these two requirements, one must consider the fact that a dozen or more different kinds of glass are needed in making a wide variety of instruments. This is particularly true of photographic objectives. We no longer use a few flint glasses and one or two different crown glasses, but a whole series of each. Each one is put in by the designer to get the precise effect he desires in the particular kind of lens that is being made. It is easy to see that glass making is a very important part of optical manufacturing and that best results can be secured when the glass, as well as the lens elements, is made according to the specifications of the designer.

It is interesting to note that the emergency of war was needed to impress this fact on the American optical industry. In 1912 no optical glass was made in the United States. Some progress toward commercial production had been achieved by 1916, but it was in 1917 and 1918, with the help of the Geophysical Laboratory and other Government Departments, that the intricate difficulties of this special type of manufacturing were overcome in this country. Glass was needed then in enormous quantities for military purposes, and, in spite of the enormous obstacles that always attend the founding of a new industry, the glass was made and it served its purpose. This war time product was in many ways not all that could be desired by the optical worker, but the important fact is that a new manufacturing process was put into operation on a large scale within a remarkably short space of time, and that it met the apparently impossible demands created by the conditions of that time.

This war experience showed American makers of optical goods that the manufacture of their own glass was an important item in the control of quality in their finished product. Glass making in this country has advanced so far beyond the experiments of war days that it can truthfully be stated that American-made glass is now unsurpassed in quality by even the best of the foreign products.

The next thing to consider is the design of a lens for any given set of conditions. Photographic lenses, like other technical tools, have grown into a highly specialized product. The qualities that make a lens suitable for copying, or wide angle work, would be largely wasted on a high speed camera. To analyze this condition of affairs one has to take at least a short trip into the field of optical engineering. This field is considered by the average reader as dangerous ground, and he is quite correct in his opinion. It is bounded on all sides by the realm of higher mathematics

which is truly a fearful place, inhabited by such strange creatures as *vectors*, *tensors* and *quaternions*. Space and time merge there, we are told, into one single *continuum*, and the God of the place is a strange idea called the square root of minus one. People like Einstein and Heisenberg wander around there, doing impossible things without any apparent effort.

The writer of this article guarantees that he will avoid this mathematical ground in the present discussion. In fact, he doesn't even know how to get to the place. We will stay, then, within the field of applied optics, and start at the very beginning.

The purpose of lenses in photography is to concentrate a large amount of light upon a sensitive surface which can be shielded from all other exposure to light. This concentration must consist of light rays reflected (in most cases) from the external objects to be photographed; it must assume the form of an image of those objects on the sensitive surface; and the most practical shape for that surface is a plane. In ordinary photography the surface is sensitive to only a part of the light coming from the object, the blue and violet regions of the spectrum, so that our concentration of light to an image needs to include only these wave lengths. The eye is more sensitive to green and yellow light than to blue-violet; therefore, for instruments that are focused visually we need a yellow and green image in the same plane as the blue-violet one in order to get a good photograph of what we see on the focusing screen.

What we want, then, is a plane image of an external object. According to elementary theory any achromatic lens will tend to give such an image if the object is all in one plane,—like a picture, for example, or the wall of a building. If we define the word "achromatic" in the photographic way as a lens that has the property of forming a yellow-green and a blue-violet image in the same plane, any lens will tend to give a plane image of a plane object, and this image will be an exact copy of the object when the optical axis (or lens center line) is at right angles to the object. By choosing a position for the lens at a suitable distance from the object, the image can be made as large or as small as we want it, and thus any lens which lets through a cone of light large enough to include all parts of the object will give a satisfactory image of a plane object,—to any required size. This is the conclusion of elementary optical theory. It has to be modified to take into account the aberrations,—the natural born errors of spherical surfaces,—to which all lenses are subject, but it is

strictly correct when these aberrations can be removed by proper lens design.

An ideal optical system for the camera would image each point of the object as a single point on the film and would reproduce exactly in the film image the projected angles between all points and lines of the object. Such a projection might be constructed by drawing a line from every point of the object through a point (to represent the lens center) and continuing each line until it intersects the plane of the film. This pinhole imagery is an ideal that can never be reached in practice because an aperture of considerable size is always needed in order to allow a useful quantity of light to be transmitted. Moreover, finite size of aperture adds another condition to be fulfilled; namely, that the whole solid cone of light rays reaching the lens opening from each object point must be reunited by the lens to the corresponding image point on the film. These are the ideal conditions to be fulfilled. No actual optical system can meet them completely, but they are very useful in that any lens can be judged by how far it fails to meet them.

It should be stated that this failure is not due in any way to defects in the manufacture of the lens or in the glass pieces from which it is made. The defects are natural properties of the curved boundary surfaces. They have been completely analyzed and classified by mathematical workers and are called lens aberrations. Five of them will be briefly described,—with illustrations taken from the performance of a single lens.

Let us limit the discussion for a moment to points on the optical axis, and follow the peculiar way in which a single lens forms an image of a distant object point. As shown in figure 1, each zone of the glass from center to lens rim forms a separate image of its own. These zonal images are not located at one focus or point on the axis, but are spaced at different distances from the lens. This is the defect called spherical aberration. It can be corrected in the design of a photographic objective by balancing against the similar aberration of opposite sign in a negative lens. It must be eliminated in all photographic lenses, particularly in very rapid objectives which need to have a large relative aperture, and a correspondingly large entrance window. It is never possible to bring all the light entering an objective to one mathematical image point. There are always small zones not perfectly corrected. But there is, fortunately, a practical limit to photographic definition, the size of the grain in the emulsion, which need not be exceeded in the computation of spherical correction and that of the other defects to be described.

Chromatic correction is the next essential for sharpness of an axial image point. It is a familiar fact that single lenses give a series of separate colored images instead of a single white one when the object point is illuminated with white light. The lens acts like a prism in this case and analyzes the light into its separate colored components. This is chromatic aberration. Its correction is accomplished by using more than one element in the design,—at least one positive and a negative of different kinds of glass, and proportioning them so that the color effects of the different elements neutralize each other at the image point. This is the place where a series of glasses comes in handy, for it gives the designer some freedom in his choice of material. For ordinary photographic work all that one needs is a yellow-green image computed to fall in the same plane as the blue-violet or actinic image. For panchromatic and

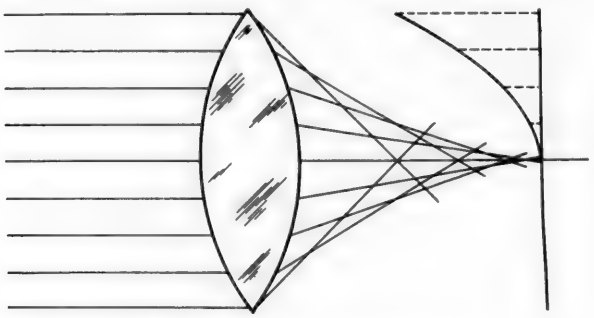

FIG. 1. SPHERICAL ABERRATION

infra-red photography the red image point must be brought to that same plane. This is not very difficult in lenses of short and medium focal length, 12″ focus for example. Objectives of long focus usually show a perceptible shift of focus with red light except when specially corrected for the purpose, and certainly should be focused with a red filter whenever the photograph is to be taken in the infra-red.

Proceeding to a point not on the optical axis of the lens, coma is the first defect that one notices in a single lens. The lens action is illustrated in figure 2 and corresponds to spherical aberration to a certain extent, as applied to oblique rays. In this case there is no longer an axis of symmetry, and the light striking the lens surface at equal heights above and below the axis has to traverse a different thickness of glass. As a consequence the image point is not sharply defined but consists of a central point, with a pear shaped blur like a comet's tail trailing from it. Hence

the name of coma for this particular aberration. It can be eliminated to a large extent by symmetry of form,—that is, by making a lens with front and back halves either alike or numerical multiples of each other. In lenses of large aperture this aberration is very difficult to eliminate completely.

Another tough objector to the correction of oblique ray pencils is astigmatism. It is diagrammed in figure 3, which shows how an uncorrected lens forms an image at O' of a point O at the margin of the field. In this case the imagery is much poorer than for an axial point; the nearest thing

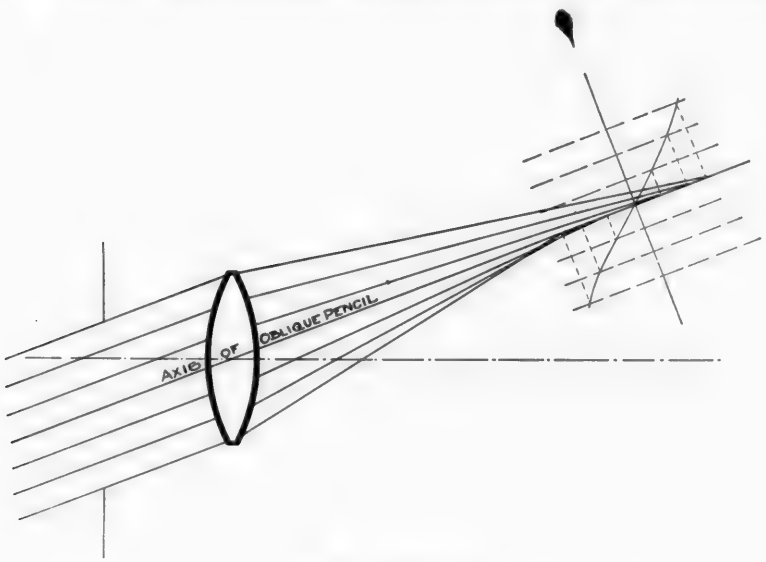

FIG. 2. COMA

to an image that we get is an elliptical spot of light. The cone of light simply does not come to a point focus anywhere in the vicinity of O'; at t' in the diagram it contracts into a short line at one place, and farther on at s' it again forms a line at right angles to the t' line. Then it broadens out into an oval spot at the image plane. t' is the focus for rays that pass through the vertical or tangential meridian of the lens aperture, and s' is the focus of the horizontal or sagittal plane. Astigmatism, then, is a faulty image quality in which a point of the object is represented in the image by two separated perpendicular lines somewhere near the correct image point. At different angles of obliqueness the amount of astig-

matism varies,—so it warps the image surface into a curve which does not coincide with the flat plane of the photographic plate. This is due to the fact that the best focus for O' is found approximately half way between t' and s'; the distance between O' and this half way point is the curvature of field for this particular angle. The location of all points t' and s' for the whole field of the lens is a pair of curved surfaces indicated by the dotted lines in figure 3. They will vary in their departure from the ideal focal plane as the field angle increases or decreases.

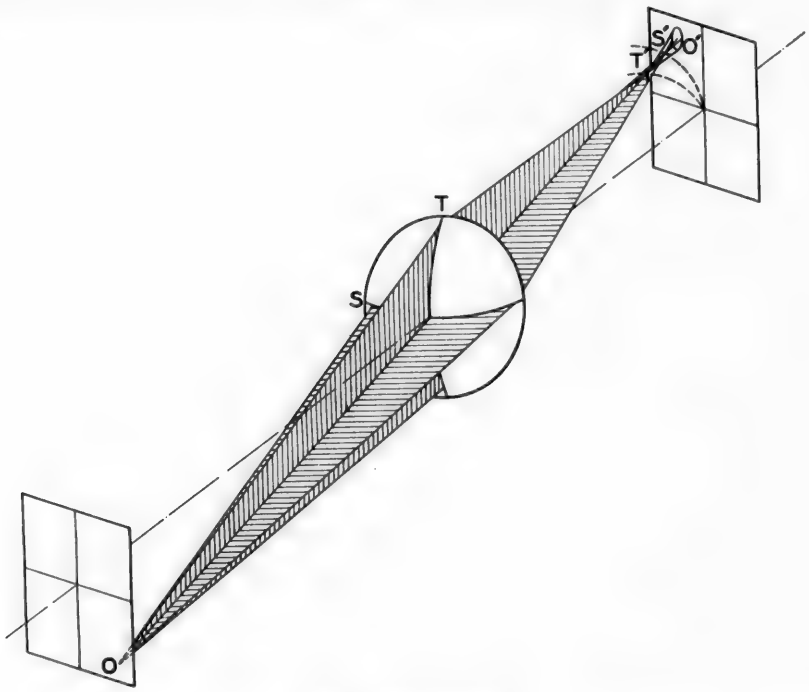

FIG. 3. ASTIGMATISM

So much for the astigmatism of a single lens. In compound lenses composed of several elements the situation is more complex and the curved image surfaces can be brought together to a large extent, that is, corrected for astigmatism. The process of flattening out both combined image surfaces is called correcting for curvature of field. This is also possible—by using proper proportions in convex and concave elements and by choosing glass and curves to the best advantage. When these

oblique corrections are combined with freedom from spherical and chromatic aberration in a photographic lens, the lens is called an anastigmat and such a lens is found to give critical sharpness throughout the whole area of its field of view.

There remain to be considered distortion and oblique chromatism. Distortion is a difference of magnification increasing or decreasing progressively from the center to the margin of the field. It is like coma in that it can be much reduced by symmetry of form, but it should be noted that this is not the only method of getting rid of these defects in photographic objectives. Distortion is very easily marked when present in a lens by the cushion shaped image it gives of a square target when the magnification increases at the margin of the plate and the well-known barrel form that a square target assumes when the distortion is negative. Oblique chromatism is a difference of magnification for light of different colors that must be completely eliminated especially in process lenses that are used for color separation negatives.

These five aberrations must all be eliminated in the design of a good photographic lens. However, one should recall the fact that it is not necessary to reduce the amount of unsharpness caused by these defects absolutely to zero. In fact, such a high degree of correction would be useless even if it were possible to attain—except perhaps for photographs that are intended to be enlarged many times. The limit of allowable unsharpness is in any case the size of the grain in the emulsion, and it is a waste of time to carry the degree of correction of an objective beyond this point even if it were possible.

Even with this exception and the wide variety of glasses that are available today the making of a well balanced design for many kinds of photographic work is not a simple process. It involves much laborious computing and the designer often finds, after weeks of paper work, that two or more aberrations simply cannot be simultaneously reduced to the required extent in the system he is working on. Every change he tries in order to be rid of one defect is sometimes found to increase another aberration. This means starting over again, perhaps adding another element, and repeating much of the work with a new system of surfaces.

Consider now the manufacturing process. Suppose that a successful photographic lens for some purpose has been designed, samples made and tested, and specifications all completed. How can one be sure that all later production is like the specifications and the sample? The lens

will usually consist of four or more elements, each made of a different kind of glass, with perhaps two or three of the elements cemented together.

Each element is first made as a pressing. Pieces of glass of the required refractive index and dispersion are selected, heated until they soften, and moulded under air presses to the approximate form of the lens. There follows a slow controlled cooling in the annealing oven to eliminate inward strain, and inspection for refractive index, for annealing quality, and for physical defects such as striae or large bubbles. Minute bubbles in pressings are allowed to pass because they do no harm unless present in large number and are always present in certain kinds of glass.

The pressings then pass on to the precision optics department to be ground and polished to the exact curves and thickness prescribed by the formula. They are cemented to an iron block with pitch and one face of the lenses is ground with emery and water against a grinding shell turned to the specified radius of curvature. Coarse emery is used at first, followed by finer grades, and the final polishing is done with rouge with a pitch surface as the forming tool. This polishing operation takes considerable time and must be continued until the glass surface is completely clear and transparent. Each element of our photographic objective is finished thus,—polished on one side.

There is a very delicate and convenient method for the testing of optical surfaces. It depends on the fact that when a polished glass surface is placed in contact with a similar surface of the opposite curvature, called a test glass, there is produced an interference pattern by the light reflected from the two surfaces. This ring pattern, called Newton's rings, makes visible differences in curvature of the size of a wave length of light; differences as small as a few millionths of an inch can be detected with the test glass. The possibility of employing a test like this is the reason for the fact that optical surfaces can be worked to an extremely accurate figure. It is simply a question of careful inspection, and repolishing when necessary, until the lens fits the test glass perfectly.

After one surface of the glass has been ground and polished, it is covered with a protective coating and the other side polished out and tested in the same manner. The lens element is now ready for centering. This operation consists in trueing up each element in a lathe one at a time, so that the two surfaces are concentric,—and turning off the outer edge of the glass with a diamond grinding wheel. The actual position of the center is determined by adjusting the lens on the lathe chuck so that

there is no optical shift or wobble in the images reflected from the two polished surfaces; the edge grinding brings the lens element down to its final diameter.

The separate elements of the lens are all finished in a similar manner, inspected and carefully checked for thickness. They are now ready to be fitted to their mounts. The mounting of the lens must be so made throughout that it holds the elements at the distances prescribed by the design and holds them in precise alignment on a common axis. To accomplish this each separate lens of the assembly is mounted in a separate metal cell. The cells are threaded to fit together in pairs, and the larger cell of each pair is threaded to fit the lens barrel. The fitting of the optical elements to their mounts is a lathe job that must be perfectly carried out. Each lens must be individually fitted and its alignment checked by observation of the images reflected from the rotating surfaces. In the final assembly the surfaces of all elements must run true in this way on their common axis, the center line of the lens barrel.

The only other process of manufacturing that need be mentioned is the testing of finished objectives to make sure of uniform performance. There is nothing in the methods used that is especially new to the average photographer. The only point that should be emphasized is the fact that equipment needs to be precisely aligned if the tests are to be of any use, and this applies both to visual and to photographic methods of testing. The test chart and the plate must be flat and parallel, with the lens axis at right angles to both, or else one gets a false picture of the performance of the lens under test. Lenses of medium focal length are usually tested on an ordinary camera with a ground glass large enough to include more than the rated field of view. Projection methods work well as a test of extremely short focus outfits, and special equipment is often needed for the long focal lengths.

Each manufacturer puts out from five to eight series of objectives with anywhere between three and a dozen focal lengths in each series. In any listing there is usually a series or two of extra rapid objectives for motion picture and press camera work, one or two of medium fast lenses from f:4.5 to f:6.3 for average use, then a wide angle series, a group of long focus lenses corrected for the three color photo-engraving trade, and perhaps a series of telephoto objectives for long distance photography. Which of these types are useful in biological work? Naturally I can use as examples only the lenses that I know, those manufactured by my own company.

The answer to this question depends, of course, upon the size of the plant,—so to speak,—and the amount and variety of work that is being done. In general, one may say that the principal characteristic of biological photography is the fact that exposures must be made at a small stop in order to cover sharply the whole depth of the specimen. The same holds true in clinical work, perhaps to a lesser extent. In such cases the medium speed objective, about f:6.3, such as the IIb Tessar, is well suited to the job. There are situations where a faster lens, like the Ic Tessar f:4.5, is really needed; and where many of these are encountered, it would save time and money to have an f:4.5 lens for the regular camera. When stopped down the definition and covering power will be more than adequate for gross photography and the extra aperture is always available when needed.

Micro-Tessars are smaller editions of the medium speed Tessar and are precisely corrected for ten to one magnification. Abundant evidence of their usefulness in making enlarged photographs has already appeared in this Journal.

There are other objectives that have possibilities in biological photography. The use of a seven or eight inch lens on the clinical camera is very common. In cases where speed is not required for specimens and there is much copying and enlarging work to be done, it would seem that a wide angle lens could be very useful and economical at both jobs. A seven inch wide angle such as the Series IV or V Protar has an aperture of f:12.5 to f:18.0 for focusing,—and covering power enough for 16″ x 16″ charts when making copies full size.

Many lens makers have a series of medium speed lenses which they describe as convertible. This means that the two halves of each objective are corrected units by themselves so that the user has three focal lengths available in one lens. Such objectives are usually symmetrical with front and back exactly alike, or hemi-symmetrical, with the back element like the front in construction but smaller in size. They are admirably adapted for enlarging work and are well corrected throughout. A seven inch Series VII A Protar, for example, gives its owner not only an excellent general purpose seven inch objective, but each of the two halves can be used alone at f:12.5 when focal lengths of $13\frac{3}{4}$″ or 11″ are needed. The addition of a third element, $8\frac{3}{4}$″ focus, let us say, makes six focal lengths possible by using all combinations of the three elements together and separately, and gives the owner almost any focal length he wants between $5\frac{1}{2}$″ and $13\frac{3}{4}$″. Such sets are very useful to commercial

photographers and will probably be found in all the larger biological laboratories as the use of photography increases there.

So much for the general situation. Specialized problems are so many and so varied that it is useless to attempt to discuss them here. The lens manufacturer is always pleased to know of these special situations that come up in photography, to discuss them, and to recommend special lenses if he thinks they are likely to be of help. It is only by this sort of coöperation between the optical industry and the photographer that biological photography can reach its full usefulness as a precise and rapid instrument of research.

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PHOTOGRAPHIC TECHNIC, NEW PROCESSES AND EQUIPMENT*

F. R. HARDING

Boston, Mass.

PRINTING BY PROJECTION

There are two types of apparatus employed in producing projection prints, the horizontal and the vertical camera. Each has some features not found in the other. The horizontal camera requires more floor space, and usually will allow the production of a larger projection print from a negative of given size. The degree of enlargement is governed by the length of the room and the length of the easel track. It is almost always a manually focussed camera.

The vertical camera occupies much less floor space, but needs a great deal of height. Some manufacturers have equipped this type of a camera with auto focussing attachments, so that the image is always in focus. This feature saves a great deal of time.

The degree of enlargement possible with a vertical camera is limited by the bar upon which the camera travels, and the focal length of the lens employed. If the camera is not equipped with a lens by the maker, one should be selected whose focal

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* From the Children's Hospital.

length will adequately cover the largest negative which can be placed in the negative carrier. The lens should be a good quality anastigmat, in order to have flatness of field with the lens diaphragm wide open. If the anastigmatic lens has a focal length which is too short, the corners of the projected image will not be sharply focussed, and the diaphragm will have to be closed until the corners are sharp. If a rapid rectilinear lens is employed, it will always be necessary to close the diaphragm to a relatively small opening, about F:32, in order to be sure of sharp focussing throughout the field. This will often increase the exposure beyond practical limits. Unless the lamp housing of a vertical camera is thoroughly ventilated, a long exposure will cause buckling of a film negative.

The illuminant for horizontal projection cameras varies widely. The carbon arc, mercury vapor "M" and "U" tubes, quartz lamps, and incandescent lamps, have all been employed. The latter type is most readily installed, and is easily replaced when it is worn out. The light source for horizontal machines is commonly placed outside the processing room, a condensing lens unit (two lenses mounted in a wood or metal cell, whose diameters are each slightly greater than the diagonal dimension of the largest negative employed) is mounted in the wall, and the camera fastened to the inner wall. The condensers are employed to produce an even spread of light over the entire negative.

The light source for vertical projection cameras is always the incandescent lamp. This is placed in a lamp housing, the inner surface of which forms a reflector. No condensing lenses are ordinarily employed. The reflector in conjunction with a graduated ground glass, and sometimes a sheet of flashed opal glass, produces an even light.

The sensitized paper employed in projection printing is made especially for the purpose, and is either a fast chloride or a bromide paper. The latter has a faster emulsion and is more generally employed. The paper used for contact printing is seldom used for projection printing as the emulsion is too slow for practical purposes. However, some photographers prefer a contact paper to a bromide or chloride paper for projection printing. Due to the slowness of this paper, the light source of the projection printer should be strong and intense, such as a good size carbon arc.

Two different methods of controlling the light are used, the hand switch, and the foot switch. The latter is always of the type called a momentary contact switch. The foot switch is by far the most practical as it leaves both hands free. Some of the older projection machines have no provision made for controlling the light and exposures must be made by means of an orange lens cap.

If dense negatives are projected and difficulty is encountered in focussing, a negative may be replaced by an old film whose emulsion has been roughly cross hatched with lines scored by a sharp instrument. It will be very simple to focus on these transparent lines. The dense negative is then reinserted in the negative carrier.

Always remember that the emulsion side of a negative faces the easel, otherwise the print will be reversed.

It has often been suggested that test strips of paper be employed to ascertain the correct exposure, and to determine the portions of the print requiring shading. However, practical experience proves that test strips do not show all the areas that require shading. They do not always give an indication of correct exposure as negatives often fall off in density near the edge, and test strips, do not always cover this area.

If the individual feels that test strips should be used on projection prints, the following method will be of some assistance:

Two strips are employed in the form of an "×," each strip passing diagonally across the field, the ends of each arm of the "×" to project beyond the limits of the print. From a test made in this manner, the exposure over the entire print may be determined, but not *all* the areas which require shading.

A number of different materials may be employed in shading uneven negative areas to produce an even print. The hand is used where large areas are to be shaded. For smaller areas, a small piece of cardboard may be placed on the end of a stiff wire. The vignette, whether it be the hand or cardboard, must be kept in motion during the shading so that an outline will not appear on the developed print. Another method utilizes a long narrow piece of glass. Opaque, a liquid matting-out medium, is placed on one end and brushed out roughly to the desired shape. Remember to make the opaque spot smaller than the area to be shaded. Do not employ plate glass for the strip, as it is liable to cause a shift of the image on the paper. Shading requires a great deal of experience, if it is to be done in an economical manner. Occasionally very elaborate shading cards must be cut, to hold back large irregular areas which cannot be shaded by employing the hands. However, a well-trained individual can cope with nearly all shading problems by employing only the hands and fingers in various combinations.

Easels for holding the sensitized paper during the exposure are made in many forms. For vertical cameras, they range from two iron bars for placing on the edges of the papers to easels with variable masking arms. The latter are designed to make white margins around enlargements, and at the same time to keep the papers flat. For horizontal cameras, the ordinary type is a hanging easel running on an overhead track. It must either have a lock for the wheels, or be so stiff in operation that the board will not move out of position while the paper is being fastened on the easel. Glass pins or thumb tacks are used to hold the paper in place. Easels have been built that had a number of $\frac{1}{8}''$ holes running diagonally from each corner, and connected with an air suction apparatus, so that when the paper is laid against the easel, it is held in place by the suction. This works well if the camera is to be employed continuously, otherwise it is not economical. Another method is to employ an easel in which has been bored a series of holes two inches apart on both edges. Elastic bands are fastened to metal pegs which fit these holes. The elastic, when stretched over the surface of the paper, holds it tightly in place.

Provision should be made for centering and straightening the image, either by equipping the easel with a false front which rises, falls and rotates, or by employing the rising front of the camera in conjunction with a rotating negative carrier. The employment of a vertical camera does away with many of these fixtures, as the easel lies on top of the table to which the camera is fastened, and can be moved to any position desired.

Any projection camera, either vertical or horizontal *must* be completely rigid. The negative, lens and easel should be in true optical alignment, otherwise the projected image is apt to be out of focus on one end or one side. If the optical alignment is not good the opposite edges are not likely to be parallel.

The safelight preferred when bromide paper is developed is of a deep orange color, however, most operators habitually use the regular ruby light designed for films.

Any good metol hydroquinone developer is suitable for bromide paper.

NEW 1000 WATT 16 MM. SOUND PROJECTOR

Bell & Howell Company announces a 1000-watt 16 mm. sound-on-film talking motion picture projector for use especially in large auditoriums with audience capacities of 2000 and more persons.

The picture-projecting component of the new Filmosound is, fundamentally, the silent 1000-watt Filmo auditorium projector, which shows most effective pictures up to 16 feet in width. It was one of these 1000-watt silent 16 mm. machines that was used recently for presenting the motion picture accompaniment of a lecture given under the auspices of the National Geographic Society in Constitution Hall, Washington, D. C., which auditorium seats 4000 people. In this particular case, the picture size was increased to 22 feet with satisfactory results.

Because of the size of the auditoriums in which the new sound picture projector is to be used, a separate-unit high-fidelity amplifier of exceptionally high-power output is employed. This will fill any average-sized theater or auditorium.

Bearing witness to the superlative character of the new machine is the fact that provision is made for the operation of two film projectors, with the necessary changeover controls. Changeover is made in the sound and picture simultaneously, by a single control. A control is provided for the correction of high and low line voltages, and the indication of the correct setting is observed on a special voltmeter.

There has been provided a sound volume control, a microphone volume control, a tone control, and a microphone jack. The regular Bell & Howell arrangement of "AC-DC" operation has been retained and all plugs and receptacles have been so arranged that only correct connection is possible. All tubes and cables are mechanically and electrically shielded and consequently are protected from damage and from electrostatic disturbances.

Bell & Howell's 750-watt 16 mm. sound-on-film reproducer has been so enthusiastically received that it will without question continue to be the all-round favorite for regular industrial sales promotion and for educational work, and wherever extreme portability must be considered. However, there are certain requisites as to sound volume and size of pictures which only the 1000-watt machine can meet. In some ways this new reproducer can well be called a semi-professional sound movie projector.

The entire 1000-watt outfit is housed in two carrying cases, one weighing approximately 55 pounds and the second approximately 105 pounds.

Book Reviews and Abstracts

THREE ARTICLES ON X-RAY CINEMATOGRAPHY

1. "Roentgen Cinematography." R. F. James, Research Dep't., Westinghouse Lamp Co.. *Journal of the Society of Motion Picture Engineers*, March, 1935, V. xxiv, No. 3.

Summary—"This paper primarily treats of the advantages of x-ray motion pictures from the physician's and anatomists's points of view. To this end the author cites two examples in which a test apparatus making x-ray motion pictures has been used for diagnosis and medical research.

The requirements necessary for satisfactory motion pictures are outlined, and the limiting factors of the apparatus that has already been used are discussed. Descriptions of two test arrangements of apparatus are given." *End of summary.*

The two examples mentioned above concern photography of the kidney, and thymus gland. "The use of x-ray motion pictures, furnishing a progressive record of motion, has proved conclusively that the muscle tissue in the urinary tract has a functional purpose and that this function is well coördinated. It has also shown that disease will affect this coördinated function, and hence x-ray motion pictures furnish another diagnostic procedure. We know now that the normal kidney and the ureter pump their contents with a rhythmic motion and do not depend on gravity." Motion picture photography of the thymus was used in a hospital where several still x-rays of different infants showed a large shadow in the chest in the general location of the thymus. Yet these infants showed no typical symptoms of thymus enlargement. Serial pictures showed that the shadow attributed to enlarged thymus had a motion coinciding with the pulse, and was in reality caused by the heart in one phase of its action.

The author discusses the two schools of x-ray motion picture photography, the direct periodic x-ray image, and the photography of an image on a fluorescent screen. The objections to the first method are the time, patience and cost involved. The film is cumbersome, and too expensive for many "retakes." If tracings are made to be re-photographed on motion picture film, they must be skilfully executed, otherwise the final film will have a decided flicker. However, the method provides sufficient contrast so that physical measurements can be made. With care, and a knowledge of the optics involved, it is possible to make computations to determine the actual size of the organ and periodic changes in volume. The second method yields a film more like a real motion picture, although the number of frames per second is reduced because of the low intensity of visible light from the fluorescent screen. This light of low intensity forms an image that is not sharply defined. The limitations are of a mechanical nature in this second method, and are gradually being overcome by improvements in screens, faster films, etc.

2. "Historical Notes on X-Ray Cinematography." R. F. Mitchell, Bell and Howell Co., Chicago, Ill. and L. G. Cole; Cole Laboratories, New York, N. Y. *Journal of the Society of Motion Picture Engineers*, April, 1935, V. xxiv, No. 4, pp. 333 ff.

Summary—"The history of the various attempts to make x-ray movies is briefly traced. In the beginning there was only visual examination. When it became possible to take still x-ray photographs, the next step was to "animate" them by producing a series of stills showing different phases of movement.

With improvements in x-ray apparatus and reinforcement screens, the time of exposure was reduced so that it became possible to take a series of photographs on a long strip of film. Speeds up to four pictures per second have been reached, though one experimenter claims speeds up to fourteen frames a second.

The "frames" so taken are copied on 35 mm. or 16 mm. film and shown in regular equipment. The 16 mm. display device attracted great interest at the Chicago Century of Progress Fair, and has since excited like interest at other popular expositions.

The methods employed to animate x-ray films are not only of historical importance, but were of considerable legal importance in connection with patent litigation on regular motion picture animation processes." *End of summary.*

This paper, as the summary indicates, traces the development of x-ray cinematography both by the direct and indirect method. The techniques were first evolved in attempts to photograph the motor function of the stomach, and the processes of deglutition. They have since been applied to other studies, particularly of the kidney and heart. A cinematographic presentation of serial roentgenograms established that the once prevalent idea that the stomach held food for several hours until it was digested, and then rapidly evacuated it, was erroneous. In one case prints were made of a set of x-ray films and cut-outs were made of the outline of the stomach showing accurately its size and shape and the peristaltic waves. This procedure of photographing white card-board cut-outs of the stomach probably was the first attempt at animation. The resulting film was shown in 1910. It is of legal interest in that it antedated by about ten years the animation of *Felix The Cat* by Pat Sullivan, and so has been significant in patent litigations covering animation of motion picture films.

Photographs and text describe the Roentgenocinematographic apparatus designed to move film ten inches wide, installed in the Joseph Purcell Memorial Laboratory at the Fifth Avenue Hospital, New York City.

This article includes a list of references.

3. "X-Ray Cinematography," *The British Medical Journal*, February 23, 1935. No. 3868, pp. 380, 381.

Two demonstrations of cineradiography by different methods were given in London the week of February 10th; the first at the British Institute of Radiology by Dr. A. E. Barclay of Cambridge, and the other at the Section of Radiology of the Royal Society of Medicine, by Dr. Russell Reynolds. Dr. Barclay's films were made by the direct method, for the special purpose of studying the movements of the alimentary canal. The size of the pictures obtained was 5″ x 5″, and the speed from one to eight pictures per second. Dr. Barclay also described a method of studying digestive motion with

pills coated with celluloid. These were swallowed by the subject at intervals the night before examination. The next morning they were found scattered through the large bowel. Exposures made at the rate of eight a minute showed the movement of these pillules to be small and slow. When the movements were plotted on tracing paper it was found that the pillules were in most cases travelling not onwards but round in circles, suggesting that these minor movements of the large intestine were not propulsive in character, but were designed to turn the contents over, and promote absorption and equality of consistency.

Dr. Russell had made his films by the indirect method of photographing a fluorescent screen. He reported that since a previous talk of his, last May, nearly three hundred subjects had been examined and quite a library of films had been accumulated. He had been able to increase the speed at which many subjects had been photographed by 50%, and this had proved particularly valuable in examination of the heart. He had chosen the indirect method in order to evolve a technique simple enough to be used as a routine in radiological cases under suitable circumstances. He showed three reels. The first dealt with the movements of the hand and joints. The second film showed the movements of the alimentary tract, in normal, and in various pathological states. One of the most striking features was the variation in the appearance and behavior of the stomach and duodenum in the same subject at different times. The final film showed various moving structures in the thorax—the pleurae, the lungs and the heart. The latter including the physiological heart in its normal state, and after excessive exercise, also the heart in auricular fibrillation, and in pericarditis with adhesions. Dr. Reynolds added that it was now possible to incorporate in the film, along with the picture of the heart's action, an electrocardiographic tracing, and, by means of lantern slides, he described and illustrated the apparatus by which this was done. He also demonstrated how it was possible to produce short endless bands of positive film illustrating some particular phase of movement, which could be projected for examination indefinitely, and, of course, could readily be sent from place to place for comparative investigations.

* * * *

A new book *Clinical Laboratory Methods and Diagnosis* by R. B. H. Gradwohl, M.D., has just been published by the C. V. Mosby Company, St. Louis, Mo. This book should be in the hands of all medical photographers who do any large amount of gross specimen photography. It contains an abundance of information concerning the preparation of tissues—data which will aid the photographer in the proper handling of fresh or preserved specimens.

Association News

News of the *Association's* activities is of importance to every member. News of members, as to the work they are doing—the papers they are writing—the exhibits they make—all, are expressions of the *Association's* activities. The success of *Association News* is dependent largely upon the members, therefore, do not hesitate to write the facts to us and we will do the rest. In this section will be published items that are of interest to all. Photographs of members and their activities are welcome; convention news, and photographic exhibition information of interest to the biological photographer, will be published.

Address all items regarding ASSOCIATION NEWS to Mr. Arthur W. Fuchs, 343 State Street, Rochester, New York.

The Fifth Annual Meeting of the Biological Photographic Association will open September 12th at the Hotel Stevens, Chicago, Illinois, and all sessions will terminate September 14th.

Registration will take place 8:30 a.m. to 10:00 a.m., September 12th, in the South Assembly Room, Third Floor of the Stevens Hotel.

The Chairman of the Program Committee has arranged an excellent program, copies of which may be secured from Mr. Louis Schmidt or Mr. Ralph Creer. Due to the unusual interest that has been aroused by the Association's activities, a large number of members and non-members are expected to attend.

All officers and directors of the Association are urged to be in Chicago by September 11th so that they can be in attendance at an executive meeting on that day.

* * * *

At the July 9th meeting of the Chicago Chapter of the Biological Photographic Association, Miss Thelma Baird spoke on the subject, *Polarized Light—Its Principles and Applications to Photomicrography.*

The election of officers resulted in the reëlection of Mr. William Martinsen as Chairman; Miss Thelma Baird was elected Vice-Chairman; and Mr. Loren Tutell, Secretary-Treasurer. At this meeting it was decided that, beginning with the Fall meeting, every member will be expected to bring at least one print for discussion. Such helpful criticism should be of direct value in elevating the general quality of the work done by members.

* * * *

Those attending the scientific exhibits at the June, American Medical Association meeting irresistibly stopped at the Mayo Clinic section, where Mr. Julin cheerfully explained the fine examples of medical photography exhibited.

Surgical motion pictures made by him provided an unending attraction. The excellent quality and continuity of these films revealed the work of a master craftsman. Many questions were asked as to the method of making the typed legends used as transparencies. We hope that Mr. Julin will explain his method in one of the discussion periods at the Chicago meeting.

Many persons at this meeting expressed to Mr. Julin their intention of attending the Biological Photographic Association meeting in the Fall for the reason that it is being held in the Middle West. We feel that there will be unlimited opportunity for them to satisfy their photographic interests, and we shall be happy to have them with us.

* * * *

Mr. Robert A. Sage, photographer and chemist, of the Iowa Methodist Hospital, Des Moines, Iowa, in collaboration with Dr. Julius S. Weingart, has had published a paper, *Stereoscopic Photography of Pathologic Specimens*, in the *Archives of Pathology*, 19:684–686, May 1935. This article, discussing the procedure employed in stereophotography and its advantages in clinical work, should be read by every member as it contains useful photographic information.

Mr. Sage is doing some very fine work in his production of stereoscopic transparencies and we hope that he will exhibit specimens at the Chicago meeting.

* * * *

It is interesting to know that Dr. Francis Carter Wood, of the Institute of Cancer Research of Columbia University and Editor of *The Journal of Cancer*, has for many years been personally making all the black-and-white and color photomicrographs which have appeared in the papers of his research assistants. Dr. Wood, as we all know, is keenly enthusiastic about photography and we are really very proud to number him as one of the members of the Association.

* * * *

Photomicrographic work of Miss Stella Zimmer played an important rôle in the exhibit on hematology of Dr. Groat of Syracuse, N. Y., at the American Medical Association meeting last June, which received very favorable comment. Although extremely modest about her work in the Department of Pathology, College of Medicine of Syracuse University, Miss Zimmer does commendable work in photomicrography as well as all classes of clinical photography.

* * * *

In the photography of pathological specimens, a centimeter rule should appear alongside the object. This procedure is necessary in order to obtain an idea as to the size of the viscera. A complete lack of standardization now exists in this regard—many kinds of rules are used and often none are employed. This is a matter which should be brought up for discussion at the Chicago meeting. Bring along the rule *you* employ for the purpose as well as specimen photographs showing it in relation to the specimen.

* * * *

During his August vacation, Ralph Creer found much to interest him in a trip to the photographic departments of the U. S. Army Medical Museum and the National

Geographic Magazine. These institutions maintain very elaborate laboratories for the tremendous amount of work required of them.

* * * *

The Traveling Salon was recently shown in Wichita, Kansas, Fulton, Missouri and Des Moines, Iowa.

* * * *

Dr. Richards submits the following information concerning motion pictures:

The 1935 edition of "Motion Pictures of the World and Its People" sold for 35¢ by International Educational Pictures, Inc., Boston, Mass., contains a list of motion picture films of biological interest.

G. B. Instructional, Ltd., London, is embarking on a five-year program of biological films on the following subjects: Thistle, Roots, Lupin, Cabbage, *How Plants Feed, *The Filter, The Great Tit, *The Buzzard, The Plover, The Brown Owl, Warblers, The Frog, The Tortoise-Shell Butterfly, White Flies and Tomatoes, Small Mammals, Diet at the Zoo, Bathing at the Zoo, The Amoeba, The Life Cycle of a Plant. Those marked with an asterisk are now available.

Film Productions, Ltd., London, have finished a sound film on the Private Life of the Gannet which was directed by Prof. Julian Huxley. A film on the evolution of the chrysanthemum called Flower of Gold has been produced by Steuart Films, Ltd. London.

* * * *

Elbert Little is official photographer for the Marine Biological Laboratory, Woods Hole, Mass., this summer He was elected President of the Woods Hole Camera Club last week; another B. P. A. member, C. G. Grand, was elected Treasurer.

* * * *

We welcome the following new members to the Association:

Mr. Roy M. Allen, 126 Berkeley Ave., Bloomfield, N. J.

Miss Amelia Alvey, Department of Pathology and Bacteriology, University of Toronto, Toronto, Ont., Canada.

Mr. Charles S. Apgar, 231½ North Street, Harrisburg, Pa.

Mr. Olin Baker, 678—75th St., New York City.

Mr. J. A. Bledsoe, Department of Zoology, University of Cincinnati, Cincinnati, Ohio.

Miss Mary Egan, U. S. Veterans' Hospital, Oteen, North Carolina.

Mr. Charles Frey, The Fleischmann Laboratories, 810 Grand Concourse, New York City.

Dr. Eloise Gerry, U. S. Forest Products Lab., Madison, Wisconsin.

Dr. Edwin Hutshing, Pacific Wasserman Laboratories, San Francisco, Calif.

Mr. Maurice Maltinsky, Iola Sanatorium, Rochester, New York.

Dr. Wm. A. Mendelsohn, Burton Manufacturing Co., 605 N. Michigan Avenue, Chicago, Illinois.

Dr. Goergine Moerke, Maybury Sanatorium, Northville, Michigan.

Mr. Francis H. Snyder, Francis H. Snyder, Inc., 42 East 48th Street, New York City.

Dr. R. B. Stout, 415 S. Second Street, Elkhart, Indiana.

Dr. Edwin G. Van Valey, 38 East 61st Street, New York City.
Mr. Adolph Marfaing, 450 West 162nd Street, Institute of Ophthalmology, Columbia University, New York City.
Mr. William Schanzenbach, The Fleischmann Laboratories, 810 Grand Concourse, New York City.

* * * *

Who are these people and what do they do? are often the queries voiced with respect to the officers and directors of the Association. By virtue of some sleuthing, we have been able to uncover information about these hard-working people which will interest you.

Louis Schmidt, President, has a long record of photographic and art achievement to his credit. He has taught many of our members the rudiments of scientific photography and medical illustration, and we take pride in his never-ending concern over the affairs of this society.

Years ago, before Mr. Schmidt became interested in biological photography, he was a lithographic artist and one of the pioneers in the photoengraving craft of Baltimore. While so engaged, his interest in medical illustration was aroused and after extensive study, he was called to Philadelphia where for ten years he made drawings of human histological preparations and pathological and surgical subjects for Dr. Piersol and others at the University of Pennsylvania. Also, while at the University of Pennsylvania, he became an expert photographer of microscopic subjects and gross specimens.

Mr. Schmidt's broad art experience led to his appointment as Director of the Illustration Division of the Rockefeller Institute for Medical Research in New York City where all types of biological illustration are produced. One of Mr. Schmidt's many tasks is that of planning the grouping of all illustrated pages in the journals published by the Institute, besides contributing papers on photographic subjects to this Journal. For pastime, he delights in recording many familiar New York scenes in the form of etchings and pastel or water color drawings.

Mr. Schmidt was elected to the presidency of the Biological Photographic Association, September 1934. As a charter member, he was detailed Chairman of the Committee to select the name of this organization and draw its constitution. At the first annual meeting he was elected a director. He succeeded Carl D. Clarke as Vice President when the Journal was established. As Chairman of the Program Committee for the 1934 meeting, he was responsible for a large share of its success and for having arranged for a technical display provided by manufacturers of photographic and optical materials. Through Mr. Schmidt's efforts, the competitive print exhibition was formed into a Traveling Salon which has since been viewed by thousands of interested persons.

* * * *

Leonard A. Julin, Vice President, acquired a most useful background of experience in portrait and commercial photography from 1921 to 1928. In order to extend the scope of his work, he became interested in clinical photography and soon specialized in this field. In 1929, he was placed in charge of the Photographic Section of the Mayo Clinic, Rochester, Minn., where he is today.

Mr. Julin is a charter member, was placed on the Board of Directors in 1933 and elected Vice President in 1934. He is now a member of the Publicity Committee and keenly interested in Association activities.

Because of Mr. Julin's extreme modesty, it is sometimes difficult to get him to say much about his work but a kindred soul will soon find out that he is extremely versatile in his photographic ability. The demands upon him for all kinds of motion and still photography in both color and black-and-white find him willing and ready to undertake any assignment. The exhibits of the Mayo Clinic seen at any convention are a credit to Mr. Julin's ability as a master of the photographic art.

* * * *

Miss Anne Shiras, our labor-loving Secretary, a graduate of Bryn Mawr College, studied photography in order to establish a photographic service for the Department of Medicine, University of Pittsburgh Medical School. Her first move in this direction was to join the Biological Photographic Association and attend the second annual meeting at New Haven, Conn. Here she met Mr. Schmidt who invited her to spend the subsequent summer months at his laboratory. Miss Shiras is now in charge of her department in Pittsburgh and is doing very creditable photographic work. Here she has started a lantern slide library which now boasts of over 600 slides, most of the cases represented having been photographed under her supervision. Many of the slides are in natural color and are used for current lectures by members of the faculty. She has also begun a library of motion picture films. Elected Secretary of the Association in 1934, we are all hopeful that Miss Shiras can be persuaded to retain the office for another year. Our secretary is admirably qualified for the position and it is our hope that this bit of electioneering is not embarrassing to her. It might be mentioned that she spent a large part of her vacation in August attending to Association affairs.

* * * *

S. C. Dunton, our disburser and receiver of Association funds—Treasurer—began his photographic work at the New York Aquarium in 1931, engaging in the photography of various fishes and their life histories for record purposes. Mr. Dunton's photographs have been widely used by various publications, one of which, "Tropical Fishes as Pets," by C. W. Coates, was extensively illustrated with many colored and monochrome reproductions. At present, he is engaged in making motion picture records of fishes and has in production a two-reel short subject concerning the life of the sea horse. Mr. Dunton was appointed Treasurer in 1934.

* * * *

Ralph P. Creer, Past President and present Director of the Association, was largely instrumental in organizing and managing the Association from its first toddling steps to its present sturdy stride. As the Association's first President, he served three years and was then elected a Director. He has written a number of papers on photography and is a staunch propagandist concerning the value of photography in medicine.

Mr. Creer, at the time of the birth of the Association, was in charge of the Photographic Division of Yale University School of Medicine at New Haven. He is now senior clinical photographer of the U. S. Veterans Facility at Hines, Illinois.

As one of the organizers of the Chicago Chapter of the Biological Photographic

Association, Mr. Creer has seen the chapter grow into a well-functioning organization. Under the auspices of this chapter, the Association should have much of interest to enjoy at the Fall meeting, since Mr. Creer, Chairman of the Program Committee, has arranged an excellent program. As a member of the Editorial Board of the Journal, he has suggested and introduced many ideas which have been adopted with success.

* * * *

Leo C. Massopust, Director, joined the Association in 1933. At the 1934 meeting, he exhibited a splendid collection, most outstanding of which were the photographic results of his research in infra-red photography of medical subjects for which he won first prize. He is not alone an accomplished scientific photographer but is also a skilled radiographer, being Director of the Art and Photography Department (including the x-ray laboratory) of the Marquette University School of Medicine, Milwaukee, Wisconsin. His laboratories are admirably arranged and efficiently managed.

Mr. Massopust has contributed papers on the application of photography in the study of anatomical material. He has continued his investigations in the application of infra-red sensitive materials during the past year and we are looking forward to his exhibit of additional material at the Chicago meeting. He was elected a Director in 1934 and is at present on the Publicity and Convention Committees.

* * * *

Mrs. Katherine W. Kingsbury, a Director, was our first Secretary-Treasurer and a charter member. Mrs. Kingsbury was until recently in charge of the Department of Art and Photography, School of Dental and Oral Surgery, Columbia University, New York City. She is now engaged in color photography with F. B. Kingsbury for the Howard Young Art Gallery, Mr. George Stonehill, artist, Mrs. Anette Hoyt Flanders, landscape architect, and many others. Before entering into photography, Mrs. Kingsbury was a medical artist and her photographic work in color of medical subjects reveals exceptional ability. She is a graduate of Smith College, class of 1911.

* * * *

Carl D. Clarke, Editor of the Journal of the Biological Photographic Association, is a charter member. After his service as Vice President for two years he was appointed a Director. As the need for a journal arose Mr. Clarke organized this journal, became its first editor and has successfully maintained the standards and ideals of the Association in its pages to the present time. Mr. Clarke studied art in the School of Fine Arts at Yale University after which he spent four additional years in the same subject at the Maryland Institute of Art. He then decided to specialize in Medical Illustration and therefore studied under Professor Max Brodel for two years at the School of Medicine of Johns Hopkins University. On finding out that there was a great demand for medical photography he completed the correspondence courses in still photography and cinematography of the New York Institute of Photography.

Mr. Clarke organized the Department of Art in the School of Medicine of the University of Maryland and is its present Director. In addition he is an Associate in Art as applied to Medicine at the same institution. He has written numerous articles for the medical, art and photographic literature.

* * * *

Jean Kieffer is a charter member and aided in organizing the Association and was a member of the Constitution and By-Laws Committee at the time of organization. At present, he is a Director, and member of the Committee on Motion Pictures, and Editorial Board of the Journal. Mr. Kieffer is particularly interested in color photomicrography and has done some excellent work employing the Finlay process. He is supervisor of the laboratories of the Connecticut Tuberculosis Sanatorium, Uncas-on-Thames, Norwich, Conn., where he has charge of the photographic and radiographic technical routine in the x-ray and pathological departments. He is at present engaged in research on the bacteriology of the tubercle bacillus. His photographic activities include surgical and educational motion pictures, still photography and photomicrography. With his numerous duties he finds time to lecture and write frequently on photography and radiography, and its value to medicine and the public at large.

* * * *

Adrian Ter Louw, another of our Directors, is a charter member of the Association. After receiving his B.S. degree from the University of Michigan, he devoted two years toward a Ph.D. in the biology department of Johns Hopkins University. During this period he was connected with the Department of Experimental Evolution of Carnegie Institute of Washington, working under Dr. C. W. Metz. After his departure from Johns Hopkins, he spent a year and a half at the Rockefeller Institute for Medical Research, working on ultra-violet photomicrography, under Dr. Wyckoff. He is now employed by the Eastman Kodak Company in the Medical Division, engaged in medical educational work, chiefly photography. Mr. Ter Louw served on the Print Committee for the 1934 meeting and was elected a Director in 1933.

* * * *

Oscar W. Richards, a charter member, received his B.A. from the University of Oregon, and his Ph.D. from Yale. He holds the position as instructor in biology at Yale University. In the summer he is in charge of the Department of Chemical Supplies, Marine Biological Laboratory, Woods Hole, Mass. Dr. Richards is a keen, analytical investigator of biological problems and finds his extensive photographic experience of value in recording many interesting facts. He has written extensively and published many papers. His intense interest in biological motion pictures makes him an invaluable Chairman of the Committee on Motion Pictures. In this capacity he has spent much time and labor in cataloging numerous motion pictures of moment to the Association. As a Director of the Association, Dr. Richards ably fulfills his duties and the Association is indebted to him for his wise counsel.

* * * *

Miss Grace MacMullen, a Director, upon graduation from Mt. Holyoke College, spent a year at Rockefeller Institute as one of Mr. Schmidt's students of scientific drawing, chart-making and photography. Following this training, she was placed in charge of the Illustration Division of the Rockefeller Institute for Medical Research, Department of Animal Pathology, Princeton, N. J. She is now in charge of the Photographic Department of the Babies Hospital, New York City. Miss MacMullen was appointed a Director in 1934.

A. W. Fuchs

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The Journal of the Biological Photographic Association

Official Publication of the Biological Photographic Association

VOLUME IV

NUMBER 2

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December, 1935

PUBLISHED QUARTERLY BY THE WILLIAMS & WILKINS COMPANY
MOUNT ROYAL AND GUILFORD AVES., BALTIMORE, U. S. A.

Journal of the
Biological Photographic Association

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Entered as second class matter March 15, 1933, at the Post Office at Baltimore, Maryland, under the Act of March 3, 1879.
Made in the United States of America

VOLUME IV *December, 1935* NUMBER 2

The Journal of the Biological Photographic Association

BIOLOGICAL PHOTOGRAPHY AND CREDIT FOR ITS PRODUCTION

The subject of medical photography is pertinent in an editorial appearing in the September 28, 1935, issue of the Journal of the American Medical Association. Briefly reviewing the history of biological photography, this editorial treats of the subject which has become a major interest in most institutions:

BIOLOGIC PHOTOGRAPHY

Today the great advances in medical science seem to depend largely on the ingenuity of inventors who prolong and project the senses of mankind. It would almost seem as if the human brain and the human eye unaided could proceed no further in their accomplishments. By the use of the microscope, vision is magnified thousands of times, by the use of the telescope it is prolonged thousands of miles; by the use of the cystoscope, the ophthalmoscope and similar devices it is projected into cavities that were formerly dark and obscure. With the x-rays and the various dye substances and devices that have been developed auxiliary to the x-rays, organs and tissues within the body are made apparent. Diagnosis has been greatly facilitated and much that formerly was left to imagination and guesswork is now susceptible of actual measurement and permanent record.

In the development of records as well, significant changes have occurred. In earlier times men made crude drawings of appearances which they wished to record permanently. Gradually medical art developed. The evolution of anatomic illustration, as described by Choulant, Frank, Garrison and many others, is one of the most interesting chapters in the history of medicine. Next came the use of photography for the making of permanent records, and, with the development of photography, colored illustrations, black and white motion pictures and colored motion pictures, which have successively been the focus of medical interest. Moreover, the possibilities of the use of illustrations in teaching have been extended by the development of the microscopic slide, the lantern

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slide, the stereoscopic illustration, the projectoscope, the bioscope and similar apparatus. By means of these devices medical teaching has been greatly facilitated. The future is sure to yield a vast amount of improvement beyond the results already available.

Another significant aspect of medical illustration is the development of photography for medicolegal purposes. The patient who comes to a plastic surgeon for repair and remodeling of a nose, the pinning back of flapping ears or the removal of an unsightly scar is not likely to remember after the operative procedure his appearance previous to the operation. The wise physician makes permanent photographic records of the evolution in the patient's appearance, so that the results of his work are clearly apparent.

The importance of photography as a means of recording specimens both in the living and in the dead subject cannot be overestimated. Photographs are accurate, impressive and easily interpreted. A good picture with a few words of description gives the reader an idea of the conditions actually seen better than a whole page of descriptive matter, even when written by a master in the use of words.

So rapidly has the interest in these phases of medical recording developed that there has existed for a number of years an association devoted to improvement in the art and technic of this practice. At the annual session of the Association of Biologic Photographers, just held, the topics discussed include intragastric photography, infra-red photography, the development of the surgical motion picture, the miniature camera and microcinematography. Photographic apparatus has been used for recording extraordinary motions and for making available records of the actions of organs within the body. Among the extraordinarily varied number of technicians now available in the medical field, the expert in clinical photography has an accepted position. No doubt the future development of the large hospital, the institution for investigation and the institution for medicolegal study will include, as an economic and scientific necessity, suitable equipment and personnel in this field.

The biological photographer serves those scientists who are engaged in teaching, healing, and research. These scientists have their societies and journals which are invaluable to them to facilitate exchange of ideas. Portrait, illustrative, and commercial photographic groups have long had their national, state, and local societies. Until the Biological Photographic Association was organized, those engaged in this important phase of biological photography had no clearing house for the exchange of ideas nor meeting place to foster comradeship and understanding. Scientists or photographers cannot function without their societies or journals. And, as the Biological Photographic Association has been so successfully operating and publishing its Journal for more than four years, it seems that all workers in this field should recognize the advantages of membership.

The less experienced craftsmen should welcome the shortcuts to improved technic which will come to them through the Association, its

Journal, its Exhibitions, etc. Those who are isolated geographically may use our Travelling Salons and the Loan Albums. By correspondence through the Secretary, they receive aid and advice. Our experienced colleagues are glad to share the methods they have worked out. The day for hoarding so-called secrets and tricks of the trade has passed in our craft, as it has in the sciences we serve. The contacts with other members will be found helpful and stimulating. By all working together, and we think this may best be done by membership in the Biological Photographic Association, we shall secure greater recognition for our craft and for ourselves as individuals, thereby solving a number of the difficulties under which some of us labor. To mention one of these, we should strive to secure the privilege of the *credit line* on all pages of good photographic illustrations. This is now granted by only a few scientific journals, while it is in widespread use in lay publications.

Concerted effort through an Association like ours will be more effective in securing adequate recognition in this respect. We must first convince the authors of our eagerness to coöperate with them, to the end that they will realize the important part contributed by the illustrations. Many articles would be quite feeble without the illustrations, a fact which is often freely admitted. This being the case, it would seem that a *credit line* is merely justice. If the author is willing for us to receive credit, as artists always have, the editor will hardly refuse. The editor of the largest group of medical journals has assured us of his entire willingness to do this when the author requests it, and where he leads others will surely follow. Incidentally, quite a number of editors are members of our Association.

The question of the best method to use for bringing our request for credit to the attention of the editors is a bit difficult. Usually we deliver the photographs to the author who, sometimes at a much later date, sends them with the manuscript to the editor of a journal. They may be permanently mounted on cardboard arranged in pages ready for publication, or temporarily attached to cardboard mounts. Sometimes they are sent as loose, unmounted prints. If possible they should be rubber stamped on the back of the print; otherwise on the mount, to the effect:

> Photograph made by John Smith, a member of The Biological Photographic Association.
>
> It is requested that a *credit line* in small type be printed under each page of his photographs.

This would be of great advantage to those who are full-time photographic craftsmen, and to the technicians who do part-time photography. The scientist who does his own illustrating may credit himself or not as he chooses.

We should again stress the importance of complete photographic data as a part of the description of illustrations. It may prove very important in efforts to repeat experiments and illustrations, and will add to the understanding of the plates.

If association of individuals, engaged in identical or similar work, is desirable, it seems that the Biological Photographic Association should have a strong appeal to all who practice biological photography. The dues are very low; too low to be a reason for not joining. The Association is solidly organized: the Journal is unique in its field. With a larger membership and a more widely distributed journal, the individual prestige of all craftsmen in our field would be greatly enhanced. The larger the membership, the lower the per capita cost, making possible more and better service. It is the Association's purpose constantly to improve the general average of the photographic work by adherence to high standards and efficient photographic procedures, and this can only be done through wholehearted coöperation with members of the Association.

If each member makes a decided effort to have one or more of his friends or fellow workers join this Association he will not only benefit himself but the Association as a whole.

LOUIS SCHMIDT,
President of the Biological Photographic Association.

PHOTOGRAPHY OF THE CERVIX UTERI*†

RALPH P. CREER

Hines, Ill.

Although many attempts have been made to photograph the cervix uteri, I have been unable to find any references to the subject in the literature. I have seen a few photographs of this organ, none of which could be termed successful. In most cases drawings have been used to illustrate lesions of the cervix. Proper lighting seems to be the main problem. The usual set-up consists of strong spotlights placed as closely as possible to the camera. It is very difficult to light the *entire* cervix in this manner, and a further disadvantage is the fact that the light travels practically parallel to the camera lens and the reflected rays, thereby producing a very flat picture. The cervix, which is round and has considerable modeling, appears to be all on one flat plane.

Dr. H. E. Kimble of Chicago, who has published many articles on the treatment of diseases of the cervix (1), was very anxious to make photographic records of his results. In the beginning he designed a vaginal speculum with one small bulb mounted on the lower blade. The cervix was then lighted from within the vagina. Due to the weak light and the position of the bulb, very long exposures were necessary, and an undesirable shadow was cast on the upper portion of the cervix.

About this time I met Dr. Kimble and began to help him with his photographic problems. After some experimenting the apparatus now consists of a modified large size duck bill speculum with two special low voltage bulbs mounted in the proximal end of each blade. (Figures 1 and 2.) The inner surfaces of the speculum are of jet black finish so as to avoid glare from the shiny metal. The bulbs are shaded so as to prevent any light from shining into the lens or from producing undesirable highlights. These lamps were originally attached to the commercial 110 volt current and were controlled with a rheostat so that the intensity of light could be varied. This arrangement necessitated a complicated wiring system. In view of the fact that a short circuit might be produced, thereby running the risk of an electric shock to the patient, it was decided to discard the use of commercial current. We now use a

* From the Department of Photography, Tumor Research Unit, Veterans' Administration Facility.

† Read at the 1935 Convention of the Biological Photographic Association.

series of ten flashlight batteries. The current supply to each bulb is independent of the other and it is possible to increase or diminish the intensity of each light separately. In this way we are able to control the

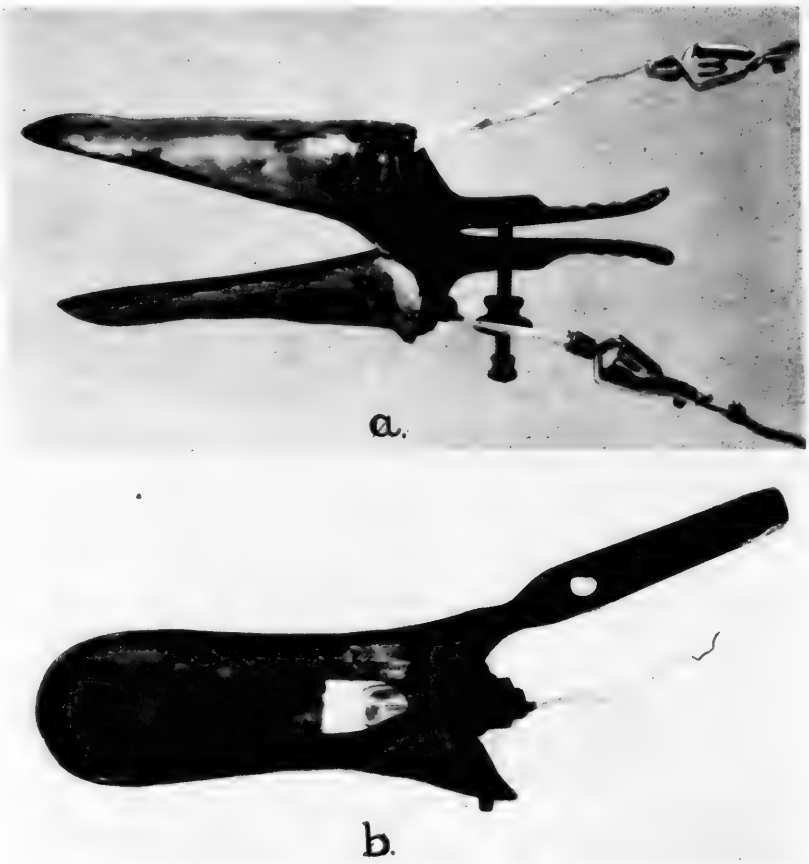

FIG. 1
(a) General view of modified duck bill speculum.
(b) Inner view of speculum showing location of lights.

lighting of our subject. For example, in some cases it is best to have the lower light stronger than the upper light or vice-versa. In other words, we are able to "model" the cervix with our lights much the same as if the cervix were not an internal organ.

With our source of light out of our way, it is a simple matter to set up any camera on a tripod that can be easily and quickly raised or lowered and make the exposure. Most of our pictures have been taken with a 5″ x 7″ clinical camera mounted on an Agfa Universal tripod. However, successful pictures have been made with a $3\frac{1}{4}$″ x $4\frac{1}{4}$″ Auto Graflex and a $2\frac{1}{4}$″ x $3\frac{1}{4}$″ Zeiss Icon with a double extension bellows. Lenses of short focal length are preferred in all types of cavity photog-

FIG. 2. END VIEW OF SPECULUM SHOWING LOCATION OF LIGHTS

raphy. A comparatively short focal length lens permits one to place the camera nearer to the subject; it reduces the exposure time and gives a greater depth of focus. Our pictures are taken about natural size with an average exposure of two seconds at F:8, using superspeed portrait film and a lens of $7\frac{1}{2}$″ focal length. Super-sensitive panchromatic film does not produce the best photographs. If the finer details of the cervix are to be brought out clearly, films that are less sensitive in the red end

of the spectrum must be used. This is easily explained when we realize that the colors of the tissues of normal and pathological cervices are nearly all composed of various shades of red.

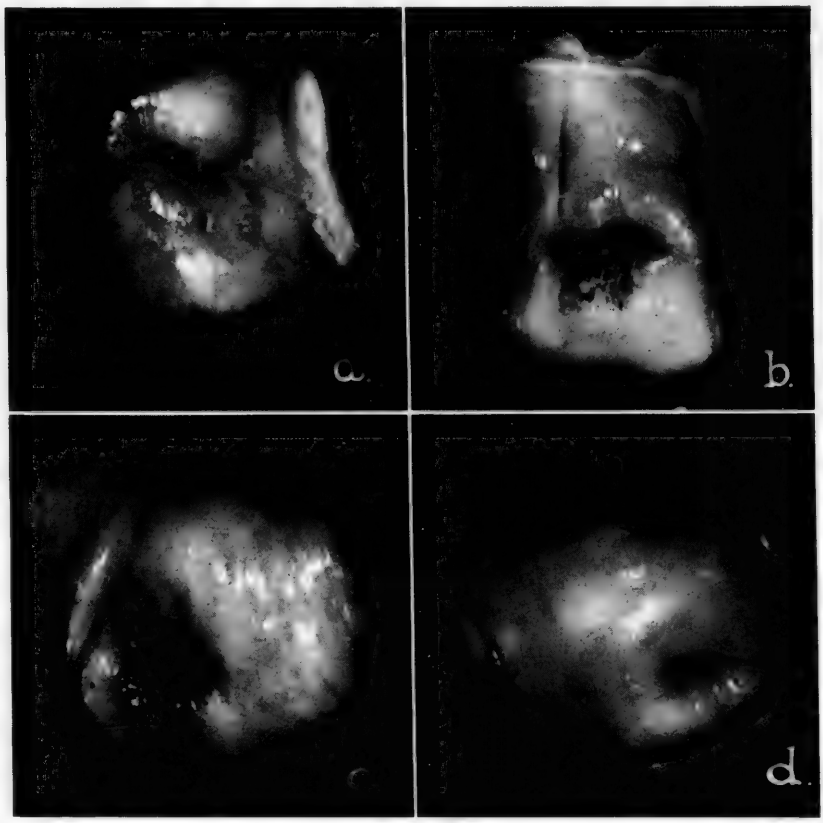

FIG. 3

(a) Chronic Cervicitis. Thick adhesion across external os resulting from treatment with cautery two years previously.

(b) Chronic Cervicitis. Bilateral lacerations surrounded with thick layer of scar tissue. Erosion on lower lip.

(c) Chronic Cervicitis. Biateral laceration, ulcerated mucosa over thick layer of scar tissue in lower lip. Tissue removed from this area showed early malignant changes.

(d) Healed cervix one year following treatment. Diseased glandular mucosa and scar tissue removed with the high frequency cutting current. Dissection operation.

Highlights on the cervix are quite troublesome. These are due to the mucus which is always present on the surface of the tissue. A powdered

mucus digestant called "Al-Cariod" may be used to remove this substance, thereby decreasing the intensity of the highlights. A small piece of moist cotton is dipped into the powder and applied directly to the cervix for three to five minutes. The cotton is then withdrawn and the excess "Al-Caroid" and mucus are removed easily with a small cotton sponge.

Blurred pictures due to movement of the patient have been few. If the patient holds her breath during the exposure, movement is minimized. We have found the ordinary office surgical examining table with suitable leg rest a very essential part of our equipment. The comfort and ease of the patient must be considered if good photographs are to be produced.

Many conditions of the cervix lend themselves to color photography and work along this line is now being carried out.

CONCLUSIONS

The cervix can be photographed best when the lights are placed within the speculum. This method has three distinct advantages. First, the light is not in the way of the camera. Second, the cervix is lighted from a slight angle and as a result modeling is possible. Third, light decreases with the square of the distance it travels; therefore, by placing lights a short distance from the cervix it is possible to use small low voltage lamps.

Comment: Often when working on the above problem, I have thought that a small photoflash bulb would be extremely useful. If such a bulb (unbreakable) could be manufactured at a low cost, I feel sure there would be a demand for them by the biological photographer.

(1) KIMBLE, H. E.: Arch. Phys. Ther., X-ray, Rad., 14:83 (Feb.) 1933.
Idem: Arch. Phys. Ther., X-ray, Rad., 14:550 (Sept.) 1933.
Idem: Arch. Phys. Ther., X-ray, Rad., 15:46 (Jan.) 1934.

DISCUSSION

Very little photography has been done in this line because of the difficulty presented by the anatomical location. Only seven of those present at the recent convention had been asked to make pictures of the cervix. Obviously, however, photographs of this region are necessary for records and for research, and a technique which makes successful photography possible is very much needed.

A source of light outside the cervix, such as a spotlight, must be so strong that details are lost in the glare. The ideal system for bringing out detail would be cross-lighting within the vagina itself.

Dr. Thal suggested that a light similar to that used in intr[illegible] photography might be incorporated in the speculum which Mr. [illegible] described. The light is a very small tubular shaped bulb, measuring about $\frac{5}{8}''$ by $\frac{1}{16}''$. It creates a very intense light, in a period of $\frac{1}{20}$ of a second. The light is produced by an arc which is created inside the air-tight glass tube. Dr. Thal has always found this light perfectly safe to use inside the stomach.

THE PHOTOGRAPHY OF THE ORAL CAVITY*†

RALPH P. CREER

Hines, Ill.

The purpose of this article is to describe two pieces of apparatus which I have used in the photography of cavities, and to discuss with you a few of my experiences in connection with this work.

CUTLER LAMP

The Cutler Lamp (figure 1) is a light especially designed for transilluminating purposes and I have found it very useful in taking pictures of the oral cavity. The lamp is a water-cooled apparatus, weighing about three pounds. A focused filament projection type bulb is the source of illumination and develops an intensity of 750 watts.

The lamp is so small in size, and light in weight, that it can be easily held in one hand while exposure is made with the other. It can be held quite close to the camera lens and manipulated so as to light properly the lesion to be photographed. Photographs of the hard and soft palate were taken at F:16, 1/5 of a second exposure, using super speed portrait film (figures 2 and 3). Photographs farther back in the oral cavity were taken at F:16, 1/2 second exposure using supersensitive Panchromatic film (figure 4). When it is desirable to show a clear outline or contour of the patient's face on the same photograph, better

* From the Department of Photography, Tumor Research Unit, Veterans' Administration Facility.

† Read at the 1935 convention of the Biological Photographic Association.

FIG. 1. THE CUTLER LAMP

FIG. 2. ULCERATIVE LESION OF HARD PALATE

pictures will be obtained if a 500-watt flood-light is placed on the side opposite the Cutler Lamp close to the camera.

FIG. 3. ELEVATED LESIONS OF HARD PALATE

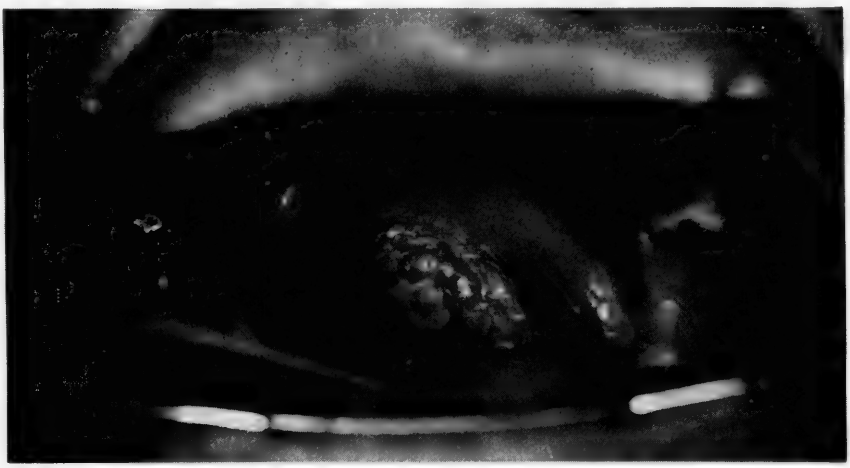

FIG. 4. CARCINOMA OF TONSIL

The water-cooling system consists of an intake and an outlet. Cold water flows continuously through a water jacket in front of the bulb.

It is essential, therefore, that a faucet and drain be situated a few feet from the patient. This arrangement is not always possible in a photographic studio and I have found it best to photograph the patient where the lamp is already set up for transilluminating purposes.

Although my experience with this light has been limited to photography of the oral cavity, I can see no reason why it cannot be used to

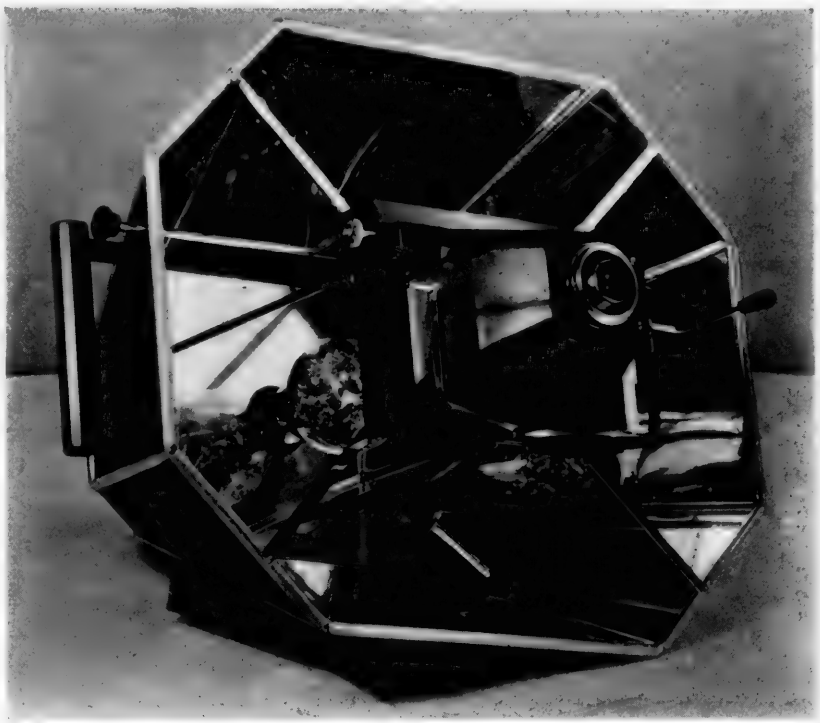

FIG. 5. GENERAL VIEW OF BURTON'S CLINICAL CAMERA

make still or motion pictures of other cavities. Its water-cooling system may prove to be an advantage in making motion pictures of operations where there is a danger of overheating the tissue.

BURTON'S CLINICAL CAMERA

Burton's Clinical Camera is an apparatus primarily designed for taking intraoral photographs. The manufacturers, however, claim that

it will afford advantages in photographing most body cavities. It was invented and developed at the clinic of Dr. Sterling V. Mead in Washington, D. C., and has been in use there for over two years. Most of the intraoral pictures in Dr. Mead's books, "Diseases of the Mouth," and "Oral Surgery," as well as those in his latest book on "Anaesthesia" were made with this camera. The camera is of special design, size and construction and is moulded of bakelite. It is mounted perma-

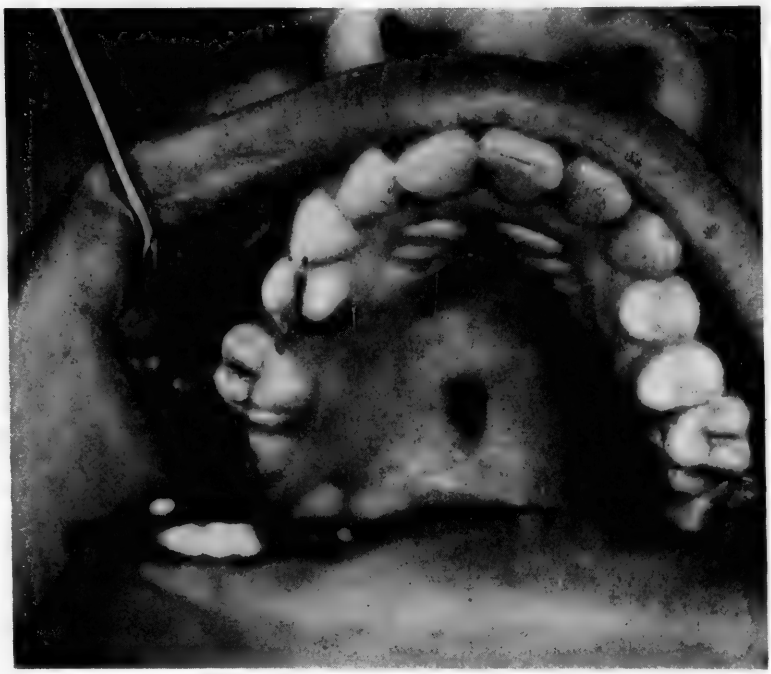

FIG. 6. PHOTOGRAPH TAKEN WITH BURTON'S CLINICAL CAMERA SHOWING PERFORATION OF HARD PALATE

nently on a specially designed reflector so that the camera and reflector make up a complete unit (figure 5). The camera is made to use regular $3\frac{1}{4}''$ x $4\frac{1}{4}''$ cut film or film pack. A 50 mm. F:6.3 Wollensak lens is employed. One small sized flash bulb is placed in the camera reflector. The shutter and light are synchronized. Thus the picture is timed by the speed of the bulb which is approximately 1/50th of a second. Most pictures are taken at F:45 and when working with such a small stop the depth of focus is about four inches (for close-up pictures) (figure 6).

Verichrome or Plenachrome film packs have been found very satisfactory in most cases. Instead of focusing the image on a ground glass the lens is set at the desired distance and the camera is "aimed" at or in the direction of the lesion to be photographed and the exposure made. Two pointers are a part of the camera and can be set at either five or seven inches. These pointers place the camera at the correct distance from the subject.

The Burton Clinical Camera has the following advantages: First, its size, weight, compactness and simplicity of operation. Second, due to the tremendous amount of light produced by the reflector system, it is possible to make pictures at a stop of F:45. Third, the fact that the shutter is synchronized with the flash-bulb eliminates practically all motion.

As I see it, there are two important disadvantages with this apparatus. First, the light travels parallel to the lens and produces a flat picture. The manufacturers claim, however, that they are developing a means of shading the reflectors to eliminate the "flat lighting" where it is not desired. Second, the camera is more or less "aimed" at the lesion, and a person must acquire some experience with the camera in order to tell just exactly how much of the lesion is included in the picture. Also, a lens of such short focal length is bound to produce a certain amount of distortion.

REFERENCES

(1) HARDING, F. R.: Photography of the oral cavity, Jour. Bio. Photo. Assn., Vol. 2, No. 1, P. 25, September, 1933.

(2) PAYNE, W. F.: "Photography of the oral cavity," Jour. Bio. Photo. Assn., Vol. 2, No. 2, P. 72, December, 1933.

INTRAGASTRIC PHOTOGRAPHY*

P. E. THAL, M.D.

Chicago, Ill.

Intragastric photography differs essentially from general biological photography in two features; first, the primary purpose is diagnosis and second, it requires special apparatus, and at least some medical training. While the primary purpose of biological photography is to make a permanent record of the things which are readily seen by the eye either unaided or by means of the microscope, the urge that brought about successful intragastric photography is the desire to view regions which could not be satisfactorily seen by instrumental aid.

What the eye can see constitutes the major part of the evidence upon which the diagnostician bases his opinion as to the patient's ailment. Many instruments have been devised to aid the eye in exploring the various cavities and hollow organs of the body; such as, the otoscope, the cystoscope, proctoscope, laryngoscope, bronchoscope and various specula. Quite satisfactory inspections can be made of the various cavities indicated by the name of the different instruments; and what the observer *sees* is of prime importance in making a diagnosis.

The stomach has always been one of the major sites of complaint in people of all times. Its large size and its importance to life and health make it one of the greatest battle grounds of disease. Yet, it has most persistently resisted satisfactory visual inspection in the living state. Many different styles of gastroscopes have been perfected, but the technique of their use is so difficult and dangerous that only a few experts in the entire world have been able to master them successfully and even they found many limitations in their use. At best, the procedure is a major ordeal for the patient.

With the advent of X-ray, the first big advance was made in the study of this important organ. This is photography of course, but of a special kind. It is radiography or shadow photography. The stomach, in order to cast an X-ray shadow, is filled with an opaque medium. Thus, we get an outline of the interior of the viscus and by serial study and fluoroscopic observation, much can be learned of its size, shape, position, activity, etc. However, only relatively large lesions can be readily demon-

* Read at the 1935 Convention of the Biological Photographic Association.

strated. The procedure does not give direct information on the appearance of the interior surfaces of the stomach. In view of these difficulties, it is easy to appreciate the value of a photographic reproduction of the inner surface of the living stomach. However, before this could be attained, tremendous technical difficulties had to be overcome.

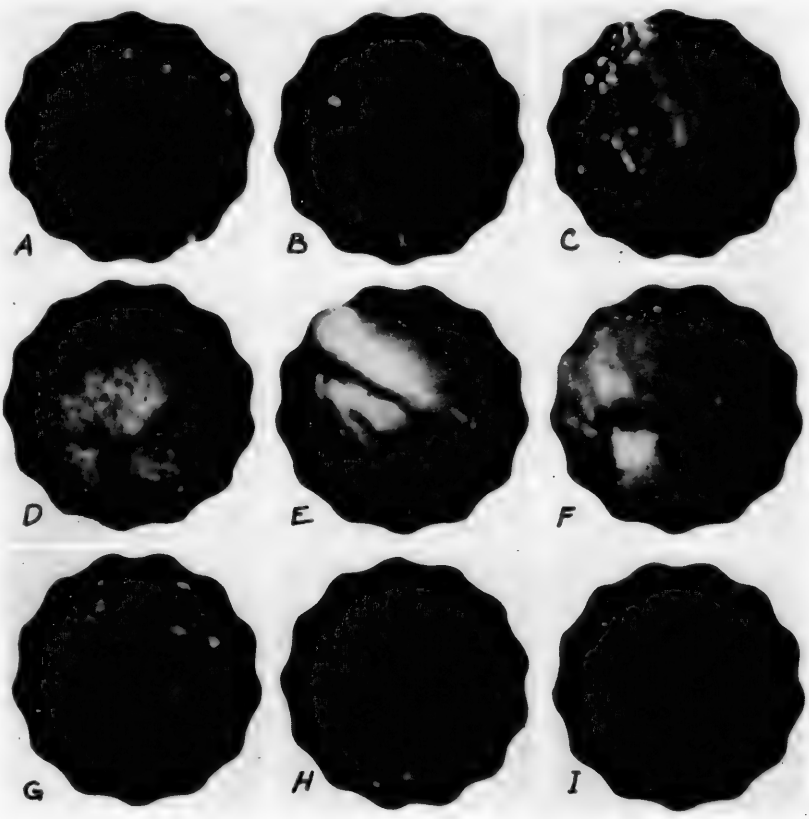

FIG. 1. *A*. Irregular ulcer interrupting rugae. *B*. One deep and two shallow ulcers on lesser curvature. *C*. Normal pyloric opening. *D*. Chronic ulcerative area. *E*. Gastroenterostomy opening. *F*. Small ulcer near pylorus which is partially obscured by redundant mucosa. *G*. Patch of small ulcers. *H*. Rugae distorted by partial gastrectomy. *I*. Small round ulcers.

When we look at the size of even our smallest cameras and consider the working distances of the shortest focal length lenses and then realize that we must pass the camera through the human throat and esophagus

and when in the stomach, have a working distance of only a few inches; it seems hopeless. It is readily apparent that a radical departure from the conventional camera is imperative. Considering that the camera when in the stomach is completely surrounded by the intended scene and long panoramic views are out of the question, it is desirable to take pictures in all directions simultaneously. In order to reduce the size of the camera so that it can be passed through the throat with ease, the focal length must be reduced to a few millimeters, or less than one-eighth of an inch, and in order to have a universal focus which would work sharply at any distance, a "pin hole" four-thousandths of an inch in diameter is

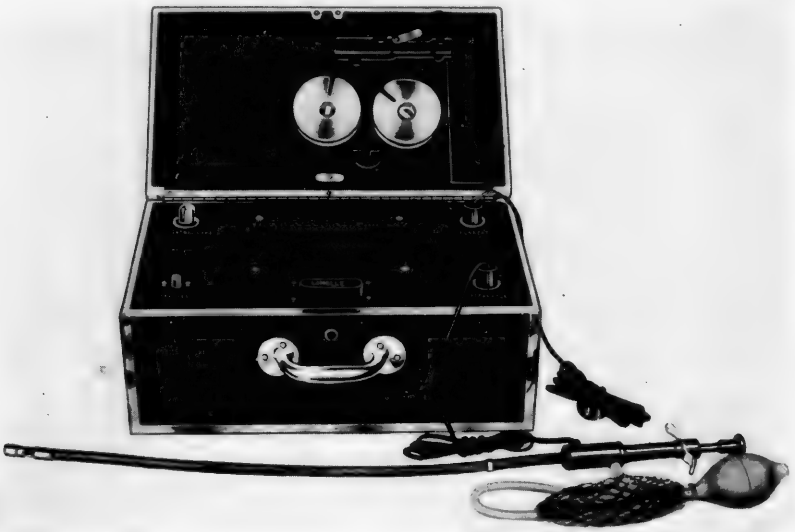

FIG. 2. THE STOMACH CAMERA UNIT

used. Then, the question of safe illumination of the interior of the stomach of sufficient brilliance to permit a short exposure, through such a small opening, is a real problem. Through the tenacious persistence of Dr. Heilpren and the keen ingenuity of engineer Bach of Vienna all of these seemingly insurmountable difficulties have been overcome. They have given us the Gastro-Photor which is the first apparatus making intragastric photography clinically practical. This is a multichambered camera and flash-light combined and is small enough to be passed into

the stomach with ease. The camera assembly is attached to the end of a flexible tube which facilitates manipulation while in the stomach.

The flash bulb which supplies the intense illumination needed is situated in the mid-section and there are four film chambers above and four below, which are directed toward the right and left, and forward and backward. Each chamber is supplied with two "pin hole" openings with shutters instead of lenses, through which eight stereoscopic views are made simultaneously. This makes it possible to take the entire circumference of the stomach with one exposure.

It has been the writer's privilege to use this apparatus for the last six years on hundreds of patients. The diagnostic information thus gained has been of greatest value in many instances. The intragastric photographs have been of definite assistance in interpreting the X-ray findings. Many small and superficial lesions could be readily seen on the photographs which could not be demonstrated by X-ray examination.

SUMMARY

(1) Intragastric photography is a valuable addition to general biological photography.

(2) While it is primarily diagnostic, it, at the same time, furnishes a permanent record of the findings.

(3) It requires special apparatus which differs greatly in size and shape from conventional cameras, but contains the fundamental photographic principles.

(4) It is easy and safe to operate. Any physician with a little photographic knowledge, or any photographer with a little medical knowledge, can readily make use of it.

CINEMICROGRAPHY WITH THE BINOCULAR MICROSCOPE*

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There are two distinct advantages in the use of a binocular microscope for cinemicrography: first, the two tubes of the microscope make possible simultaneous observation and photography; and second, no special beam splitting attachment is necessary, the binocular prism serving this purpose.

The accompanying photograph shows how such an apparatus may easily be set up. The camera, in this case, is a 16 millimeter Cine-Kodak Model B with the lens removed. It is mounted on a wooden board by means of a countersunk tripod screw. The edges of this board are grooved, and fit into a vertical wooden track fastened securely to the wall. A thumb screw and threaded bolt attached to the upper end of the board provide a free but rigid vertical adjustment of the camera.

The camera thus mounted is held firm, a factor most vital when the camera mechanism is running, yet the winding key and release button are free, as well as the cover, which is easily removed for loading and removing trial strips of film.

The microscope, a Bausch and Lomb Model FFSE, is placed in position on a solid, level table. The camera is lowered until the lens mount covers one tube from which the ocular has been removed. Actual contact between camera and scope is avoided to eliminate vibration. A cylinder of black paper is placed inside the microscope tube and extends up into the lens mount of the camera, thus serving as a light trap. (The paper should be flat black to kill any light reflection.)

The problem of sharp focusing might seem a difficult one since no ground glass system is inherent in the camera. However this is accomplished in the following manner:—The level of the film gate is first ascertained by removing the side of the camera. The eyepiece of the second tube is now removed, and a small piece of ground glass held in the horizontal plane of the film gate. It may be supported at this level by another cylinder of black paper of suitable length which fits around the second tube of the microscope.

With the shiny side of the ground glass up, the microscope is now focused until a sharp image appears. A prepared slide with good con-

* Received for publication May 15, 1935.

trast is best for this purpose. A small rectangle, the actual frame size of the film, may be drawn in pencil on the ground glass showing the actual field as it will appear on the film, as well as the magnification possible. Greater magnification is obtained by raising the camera further from the scope; however the light intensity is proportionately decreased.

After sharp focus has been obtained by means of the ground glass, this is discarded in favor of the microscope ocular or eyepiece, which fits into

FIG. 1. GENERAL VIEW OF APPARATUS

Cine-Kodak Model B, Bausch and Lomb binocular microscope and Central Scientific Company lamp.

the black paper cylinder. No further adjustment is necessary except for slight focusing of the microscope itself with the fine adjustment.

The top of the eyepiece is now in the same plane as the film in the camera. A virtual image appears in the ocular, but a real image is present on the film. When the subject is in focus in the eyepiece it is also in focus on the film. Slight variation in the level of the ocular will make no difference in the sharpness of the image on the film if the subject appears in perfect focus through the observation tube.

The amount of illumination required depends upon the type of film

to be used, as the film speed in this particular camera is constant. In the set-up pictured here a lamp equipped with a 6 volt 108 watt ribbon filament bulb is used on an alternating current circuit with transformer. A large condensing lens on the lamp throws a small spot of concentrated light on the concave mirror of the microscope. The lamp should be far enough away from the mirror to be slightly outside the focal point of this lens, in order to eliminate chromatic effects as much as possible.

Using the high power objective with this illumination, the iris diaphragm of the Abbé condenser is left open. For low power work various stops of the diaphragm must be used to avoid over exposure. The oil immersion objective was not used because it was found that the pressure of the lens on the cover slip caused agitation of the subject when slight changes of focus are made. Moreover the high dry lens gives ample magnification.

With sufficient light for good photography the microscopic field in the observation tube is generally quite blinding. This difficulty is overcome by placing a disk of calabar glass over the ocular thus providing adequate protection for the eyes. This is especially important with the low power objective.

Considerable experimentation with different types of films and developing formulae was found necessary. The film finally selected was positive film because of the better contrast it gave, even though it is a very slow film. Eastman formulae such as D-16, D-11, D-76, and even D-72, as well as maximum energy developers, did not produce a negative of sufficient density. The formula finally selected was the Victor X-ray formula. This gave the desired contrast in eight minutes.†

It should be remembered that the object to be photographed must be brought into the central part of the field, because only a portion of the visible field appears on the film, as was noted on the ground glass. Moving the preparation in the mechanical stage while the camera is running is not advised since it does not have a pleasing appearance on the screen. If the slide must be moved it must be done very slowly, and preferably from left to right.

Following the procedure mentioned, excellent films were obtained showing the morphology and movements of *Trichomonas Vaginalis*, a protozoon of considerable medical importance. A drop of fresh secretion diluted with normal saline was placed on a warm slide, and sealed under a cover slip with petrolatum to prevent drying. The heat developed by

† Editor's Note: Eastman formula D-19 will serve equally well.

the light was sufficient to keep this organism actively motile, and no warm stage was necessary.

The actual size of this interesting human parasite averages 20 microns with some variation of different individuals. The accompanying photograph is an enlargement (about 5x) from a 16 millimeter negative taken with the high dry objective. Since this is the only lens in the optical

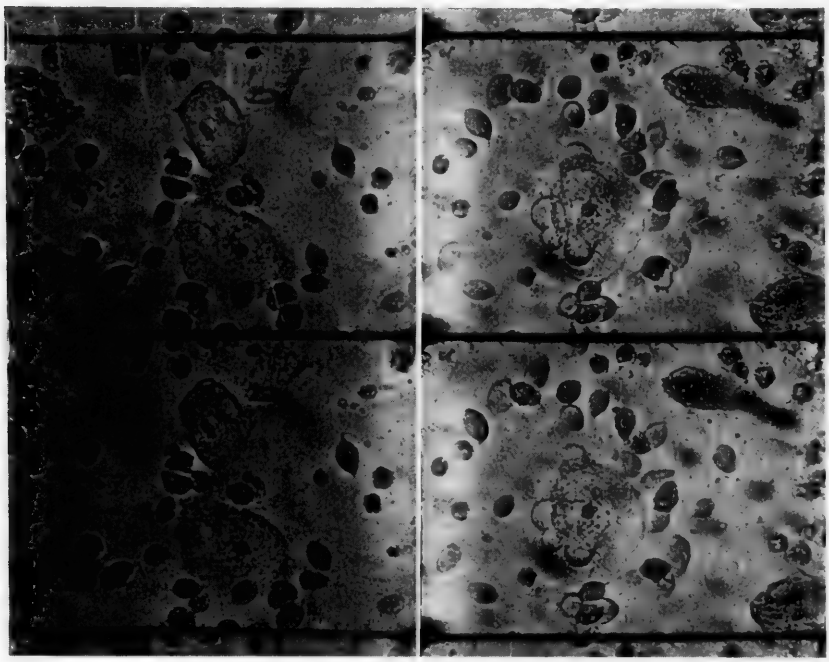

FIG. 2. TRICHOMONAS VAGINALIS

Many fusifom trichomonads (actual length 20 microns) are seen clustered about large epithelial cells. Photographed on 16 mm. positive film with 4 mm. achromatic objective. Magnification on film 43×; in photograph 210×.

system the actual magnification on the film is only about 50x, but this is enormously increased when projected on the screen.

Dark field cinemicrography of this organism brings out certain structural details not visible with ordinary illumination. A light of at least 1000 watts, and supersensitive panchromatic film are necessary for this purpose. The delicate movements of the undulating membrane and the whip-like lashings of the four anterior flagella are thus brought out in a most striking manner.

SIMPLE CINEMICROGRAPHY*

R. FAWN MITCHELL†

Chicago, Ill.

It is trite to say that the microscope is being used more and more extensively in all forms of medical work, but because of the increasing reliance on the use of the microscope, there has been an increased demand to photograph, in motion, objects seen through this instrument.

Originally it was only possible to do this with 35 mm. film and quite elaborate equipment which necessarily limited its application. Obviously there are many advantages in the use of a simple inexpensive unit which will enable the average practitioneer to make his own movies through the microscope at any time when suitable subjects are available.

Sometime ago, the writer was called to assist a leading doctor in photographing the Brownian movement (1) of the colloidal particles in the blood stream. Upon the analysis of this movement has been developed quite a system of diagnosis supplementing existing methods, so it will be apparent that photography of such subjects becomes quite important for record and comparison purposes. This is mentioned merely to indicate one of the many advantages of perpetuating such subjects.

The original work was done with a split beam prism unit (the Zeiss Microphote), which fitted over the eyepiece of the microscope. But with the high power involved in photographing colloidal particles, it was impossible to focus these by means of the 5 per cent of light transmitted through the eyepiece, so a reflex focusing unit was fitted to the camera. This consists of a sliding prism which could be moved to intercept all the light coming into the camera and permit correct focusing. As a matter of interest, the most convenient method of focusing was to bring a white corpuscle, or some such comparatively large object, into the margin of the field. This was sufficiently bright to be watched through the eyepiece, using only 5 per cent of the light transmitted. This was rendered necessary also because when using an automatic feed arc, the crater was found to move slightly—enough to throw it out of center with the cardioid condensers employed. This crater shift, of course, became visible at the edges of the field first and was quickly ap-

* Read at the 1935 Convention of the Biological Photographic Association.

† Manager Technical Service, Bell & Howell Co.

parent by watching the brilliant cell. Obviously, constant refocusing was found necessary. This was best accomplished by using the reflex prism.

For Brownian movement and high power dark field work an arc lamp

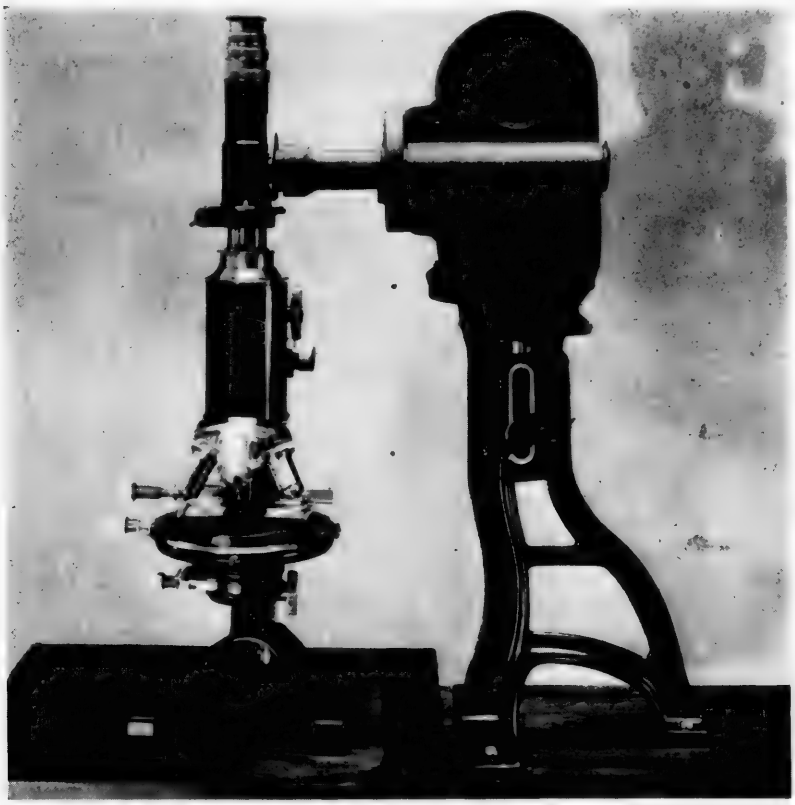

FIG. 1. FILMO CAMERA SET UP WITH ZEISS MICROPHOTE AND MICROSCOPE

will be found necessary. We tried the Pointolite and ribbon filament lamps without success.

The combination above was very satisfactory, but always involved the necessity of careful setting up. Mr. Ott, President of the Spencer Lens Company, and the writer, had several discussions regarding this problem, and as a result, Spencer has worked out a very effective and simplified device with which anyone can get immediate results. The

initial simplification was obtained by using only the objective of the microscope. While this limited the overall magnification, it was found sufficient for all ordinary work. Then again, due to the focusing being done through the eyepiece at a higher magnification, slight errors in focusing or accommodation of the eye were effectively offset. Naturally this facilitates accurate focusing by inexperienced operators.

An important innovation was the collimation of the light so that it left the horizontal adapter tube in parallel rays. This had the advantage that the regular lens on the camera could be employed to focus the image on the film, using the lens at the infinity setting. In other words, the simplest ciné camera could be employed. Another great advantage

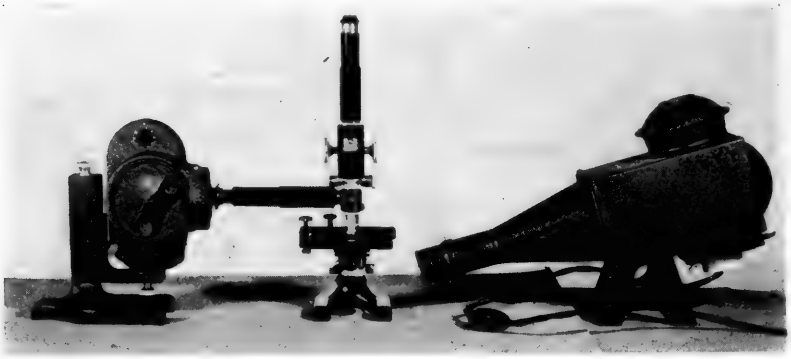

FIG. 2. FILMO CAMERA SET UP WITH SIMPLIFIED SPENCER CINEMICROGRAPHY ATTACHMENT

was the ease of alignment of the camera and the elimination of any light traps and possibility of fogging the film. In addition, a most efficient camera stand completed a well balanced, carefully designed cinemicrography outfit.

In conclusion, it may be pertinent to mention that panchromatic film was found most suitable for work involving up to 300X power. For dark field work, orthochromatic film was found necessary in order to obtain the necessary contrast, despite the relatively slow speed of this film with artificial illumination. Using the Zeiss 3 mm. oil immersion objective with a cardioid condenser, the most successful Brownian movement pictures were obtained using a 10X eyepiece. At this magnification it was found preferable to run the camera at 8 speed in order to get

adequate exposure even though the arc was forced to the utmost. The Spencer device will be found desirable for all ordinary requirements because it permits magnification as high as employed in ordinary work. Its great simplicity and the ease of reproducing results are among its strongest advantages.

It may be in order to repeat the information which has already been published in the Journal covering a convenient method of checking exposure. The following is quoted from a letter written by Dr. R. B. Stout, formerly of the Jackson Clinic, Madison, Wisconsin:

> The arrangement for use of the Photometer should interest you. If a small piece of ground celluloid is fastened over the lens farthest from the eye, the intensity of light projected to that point may be measured just as readily as reflected light by the usual way. I found it convenient to add another arbitrary scale to the outer rotating segment, numbered from 1 to 20, and after taking a series of shots through all three microscope lenses with the light so regulated as to match up the filament intensity with the rheostat set at 5, 10, 15, and 20 on this scale, I find that uniform exposures may be obtained at any magnification, and through any color filter, merely by setting the Photometer scale at the proper point (regular film 10, panchromatic film 8, supersensitive film 7), and regulating the light intensity by means of the projector rheostat or the iris diaphragm below the condenser till it matches the filament brilliancy.
>
> The Photometer can thus be used to measure the intensity of projected light in many other commercial fields, and with the addition of neutral density filters to the ground glass screen in front of the lens, its range could be increased to the point that it would be possible to measure accurately arc and other high intensity illumination. This is a suggestion, but I think you may see its possibilities.

REFERENCE

(1) "Cinematography of Brownian Movement." Journal Society of Motion Picture Engineers. Nov. 1930, Vol. xv, No. 5, p. 679–688.

ROUTINE RECORD PHOTOMICROGRAPHY*†

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The microscope is so indispensable to diagnostic routine that mere mention of that fact seems to be superfluous. Yet, the logical, modern adaptation of microscopy remains, to many practitioners, a deep mystery. Because of this widespread inability to obtain good visual results with a microscope, the photomicrograph is often better for study purposes than direct visual examination. Moreover, the photomicrograph offers a permanent, detailed record.

Can anyone who does not understand enough of microscopic technique make a photomicrograph of good quality? We should hardly want to say that, but there is scarcely a laboratory technician of even ordinary ability who cannot learn to make good photomicrographic records in a short time. In this way, his or her superior may have these records for study, for comparison, and for filing with case records.

The idea seems to be prevalent that photomicrography involves profound technical skill which is not possessed by the average microscopist. This was true a few years ago, but today it is not. Of course there are certain phases of photomicrography involving high resolving power, optical sectioning, ultra high power and so on, that certainly does demand the highest skill, experience and a roomful of elaborate (not to say expensive) equipment. On the other hand there is no reason why any laboratory technician, or any medical man, should not make routine photomicrographs with no more trouble or equipment than that used for making snapshots of the children.

The equipment consists of your laboratory microscope and a hand camera which maintains the film or plate rigidly in the exact focal plane. The camera used for the experimental work in this field was chosen because rollfilms, cut films, or glass plates may be used interchangeably and because the reflecting feature makes it good for personal use, for case history records, and for routine clinical work. The whole idea is to avoid using any special equipment which could be used for no other purpose.

Two obstacles which confront every photomicrographer are, vibration, and lens aberrations. With the equipment suggested, the exposures are

* From the New York Institute of Photography.
† Received for publication April 1, 1935.

short enough so that vibration rarely interferes. It is true that ordinary microscope objectives are not designed for photography, but if we use a sufficiently small substage diaphragm, and a color filter that is very roughly monochromatic, we lose most of the aberrations. If we make use of green and red filters we limit the light to a band sufficiently narrow to give satisfactory definition with even inexpensive objectives. We then have sufficient light so that exposures are not too long, and using these

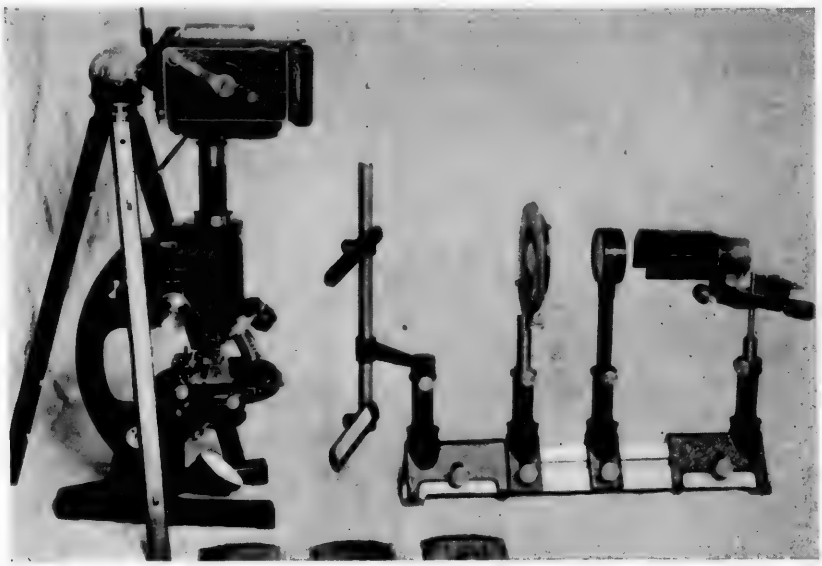

FIG. 1. THE ROLLEIFLEX CAMERA SET UP AS DESCRIBED IN THESE PAGES

two contrasting colors, we still have the usual advantages of color filters with stained specimens.

As a rule glass plates are preferable because of their rigidly flat plane, but with the pressure type of holder used with the camera mentioned, cut films may be used with satisfaction. When plates are used the Wratten & Wainwright "M" plate is very good, but the hypersensitive plate of the same manufacturer gives good results when short exposures are desired. Panatomic cut film is both fine grained and about 60% to 75% of the speed of the supersensitive types. A full range of filters may be used with all these materials.

Set up the microscope, placing the light directly opposite the center of

the instrument. Any good lamp will serve, but one which is equipped with a condenser and an iris diaphragm is best. It is usually advisable to use the ground glass diffuser in front of the condenser lens.

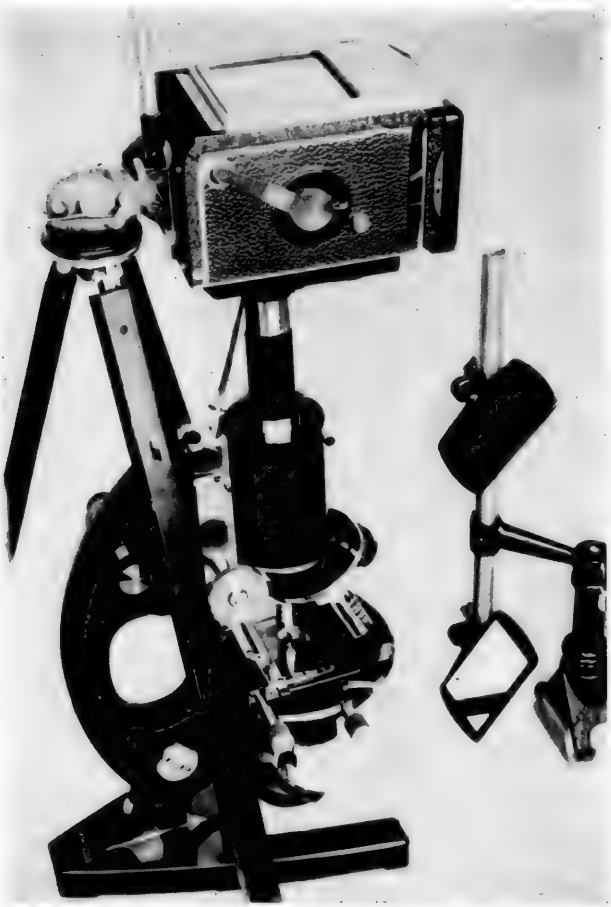

FIG. 2. DETAIL VIEW OF THE CAMERA READY TO MAKE A PHOTOMICROGRAPHIC RECORD

The object is to obtain photomicrographs which will be crisp and sharp, not overlaid with a haze or veil.

Place a slide on the stage of the microscope. A stage micrometer or centering slide is convenient, but any which has crisp detail will do.

Focus the instrument. Remove the eyepiece and look into the tube. Close substage iris until the images of the blades are just seen encroaching upon the illuminated field of the back lens of the objective. Replace the eyepiece and focus the instrument until you see the grain of the lamp ground glass. Close the lamp iris until only a small circle of light is seen. Move the lamp until this is centered in the field, then open it barely enough to clear the field. These two operations limit the amount of light to that actually used and so prevent fog and haze.

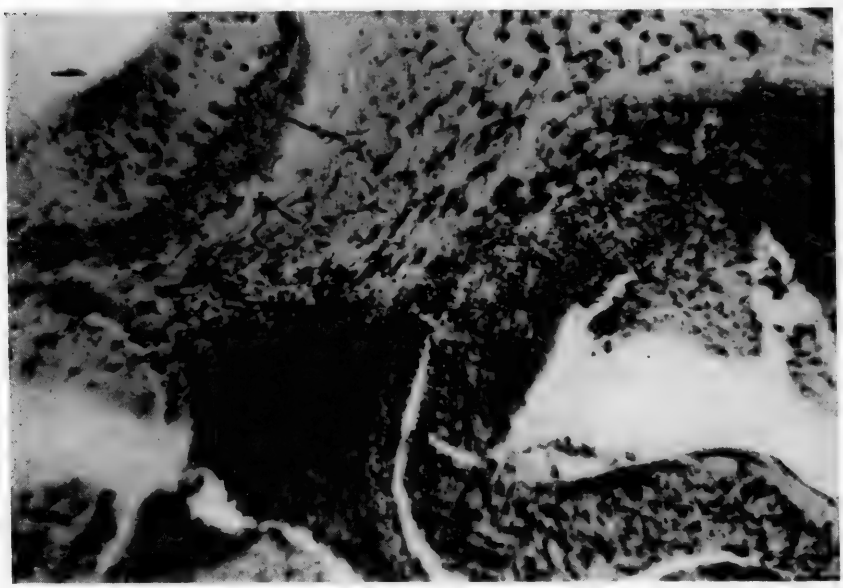

FIG. 3. SECTION OF BRAIN TISSUE STAINED TO SHOW THE NEURONS

Place the specimen to be photographed upon the stage and focus upon it. Lower the substage condenser. The apparent contrast will increase, but too much of this will cause the appearance of heavy black lines which are false, so that the condenser should be lowered just enough to make the details stand out in contrast against the background. Theoretically the condenser is always in focus, but as most laboratory workers have no means to alter the intensity of the light, and as very slight, false diffraction lines help the contrast, the method described is satisfactory.

It is assumed that the camera is at hand and that the holders are loaded

with the sensitive material you plan to use. Some support is necessary to hold the camera in a horizontal position over the microscope. An ordinary metal tripod with a tilting head is convenient. These are standard photographic accessories and may be obtained from any dealer in photographic supplies.

Records are important, for careful records kept for two or three months will enable you to perform this simplified photomicrography as easily as you use the microscope visually. The data include: Light source

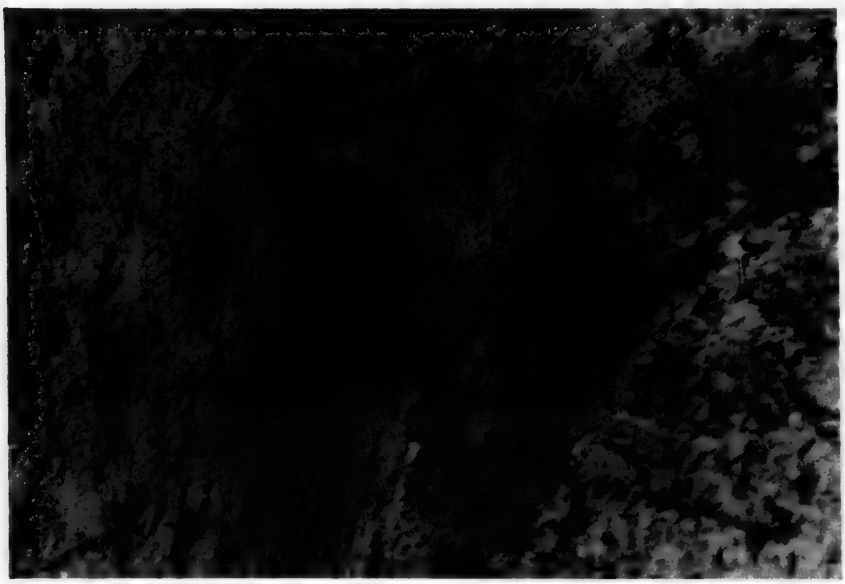

FIG. 4. BRAIN SECTION PHOTOGRAPHED WITH A 20× OBJECTIVE

used; distance from center of light to center of microscope mirror; approximate focal position of condenser; objective used; eyepiece used; tube length if other than normal; the type of film or plate used and the exposures given.

Using the tilting tripod head, set the camera in a horizontal position, then by drawing out the legs or spreading them, set the camera so that if placed over the microscope the lens will just clear the eyepiece of the microscope by one or two millimeters. If the camera lens is used it must be set at infinity. However, it may also be removed entirely from

the camera. In such a case the optical system of the microscope serves to form the image on the ground glass. If the room is not brightly illuminated no further precautions against stray light are necessary, but if the light is strong, a disc of cardboard about three inches in diameter is cut and blacked with ink. A hole just large enough to admit the barrel of the eyepiece is cut in the center of the disc. The eyepiece is removed, slipped through the hole and then replaced. The disc is supported at the top of the microscope tube, serving as a light shield.

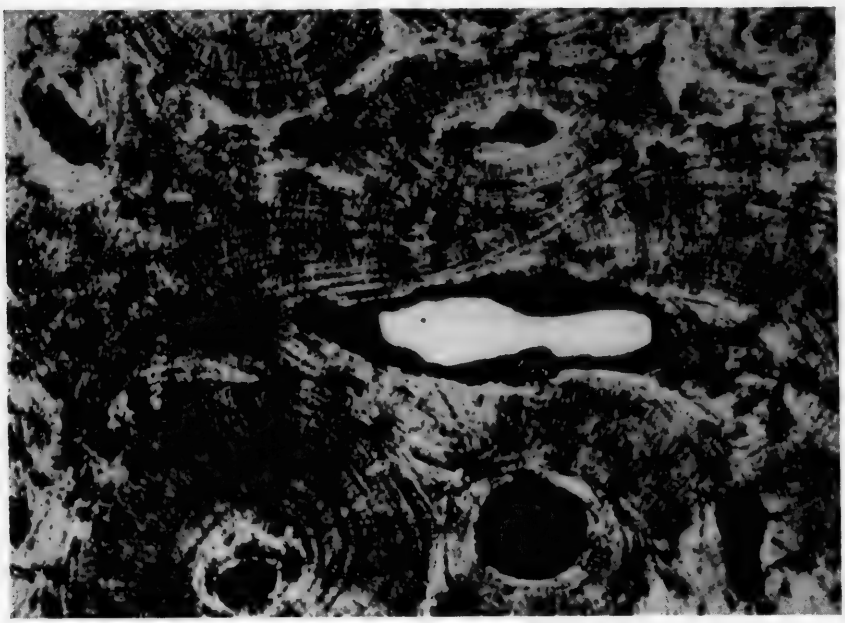

FIG. 5. SECTION OF HUMAN BONE PHOTOGRAPHED WITH THE OUTFIT DESCRIBED

If the microscope is focused at infinity, as it always is by experienced operators who permit their eyes to rest while the instrument does the work, the camera also being focused at infinity will result in sharp pictures. It is advisable however, to use a focusing screen or ground glass back in the camera, and focus the microscope while observing the image on this screen. This is true whether the camera lens is used or not.

Withdraw the focusing screen and replace it by a loaded holder. Close the camera shutter and draw the dark slide from the holder. You are

now ready to make the exposure. The duration of the exposure must be determined by experiment as there are too many factors involved to warrant even a guess. The only thing to do is to make preliminary tests, then keep records and from the records control future exposures.

If desired, exposure tests may be made on rollfilm, because critical focus is not essential in such tests, and factors from film to plates are easily made by information which will be supplied by the manufacturers of films and plates.

FIG. 6. A SUGAR CRYSTAL PHOTOGRAPHED WITH POLARIZED LIGHT

Exposures of $\frac{1}{5}$ second, 1 second, 2, 4, 8, 16 and 32 seconds will be sufficient. One of these is almost certain to be close to correct. A second test following the first should give you the absolute exposure. Thus if the 8 second test is light and the 16 is dark you know that the exposure lies between these extremes. Then exposures of 10, 12 and 14 seconds will give you the final information.

Short exposures, that is of one second and less may be made with the camera shutter, but longer ones should be made by placing a dark shield

between the lamp and the microscope, opening the camera shutter, lifting the shield for the desired time, lowering the shield, closing the camera shutter and closing the holder.

Exposures change with magnification; numerical aperture and filter factors. Filter factors are given on cards packed with panchromatic

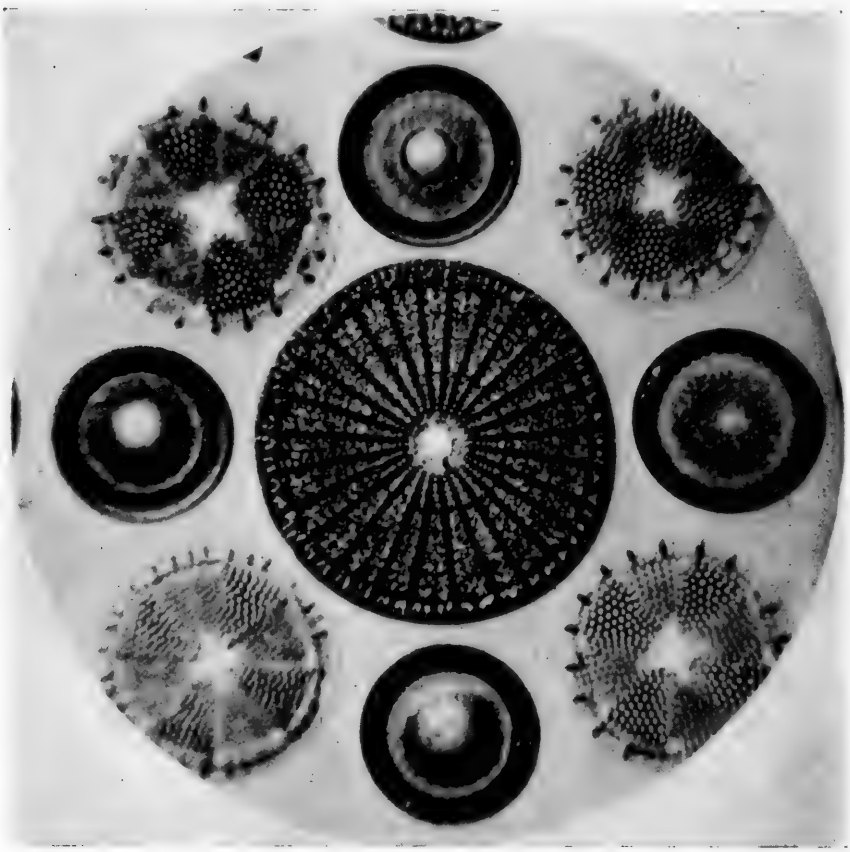

FIG. 7. Detail in diatoms is usually accepted as a criterion of quality in photomicrography, yet as shown, this same subject is rendered quite well with the simple outfit described.

materials. The exposure factors for magnification are given here. (Magnification is the primary magnification of the objective multiplied by that of the ocular. Thus a 10× objective and 10× ocular gives 100× magnification at the point where the eye look into the ocular.)

Magnification	*Exposure factor*
10	0.01
20	0.04
25	0.0625
50	0.25
75	0.5625
100	1.0
200	4.0
500	25.0
1000	100.0

Exposure varies as the square of the magnification.
Factors for numerical aperture are:

Numerical aperture	*Exposure factor*
0.10	25
0.25	4
0.50	1
0.65	0.666
0.85	0.333
1.25	0.125

The numerical aperture of the objective will be found on the barrel of the objective.

Exposures should be made both with and without a filter. For preliminary work two filters will suffice, the "A" and the "B" made by Eastman Kodak Company. The "A" filter is red and the "B" green. Any simple support which will hold the filter between the lamp and the microscope mirror is all that is necessary. When the color of the specimen is of a hue that will permit, the green filter should be used as it is most favorable to the eye. If however, the specimen is stained red, it will print out solid black in the final print, losing all detail, so, if detail is wanted, the red filter is used.

Our primary purpose in using a filter is to eliminate color errors of visual type objectives, but we can also control detail as we have just seen. Filters the same color as the stain give detail at the cost of contrast. Filters of opposite color give contrast at the expense of detail.

Development is that used for ordinary snapshots. You are not expected to go into special, controlled development. While the method described will not bring you a reputation as an expert photomicrographer, it will serve to produce many valuable and interesting records which would not have otherwise been available.

AN IMPROVED METHOD FOR RECORDING PULMONARY MOTIONS*†

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The method reported here was devised to meet a particular need; namely, the graphic representation of the motions of the lungs, diaphragm and thoracic cage in cases of bilateral pneumothorax. Though its medical aspect is beyond the scope of a paper on photography, in its development some very interesting photographic problems were thought to be worth presenting.

Briefly, the method is as follows: Two radiographs are taken, one at full inspiration, one at full expiration. Simultaneously a spirographic record is made, showing the difference in lung volume which occurs. The radiographs are then slightly retouched, the outlines of the lobes, diaphragm and thoracic cage being emphasized in order that they be not obscured too much in the latter steps of the process. They are then superimposed in register with bony structure landmarks. A tracing of the spirographic record is added and the composite is photographed, then reproduced by the usual means. The final result shows the pulmonary motion which has taken place simultaneously with a known difference in lung volume, together with arrows showing the direction of motion, or any other explanatory matter.

The original trials were made by taking the two radiographic exposures on one film. This proved unsatisfactory for two reasons. First, some of the outlines were lost; or it was difficult to decide to which respiratory phase they belonged; second, the patient usually moved enough to vitiate the results, due to the effort necessary for full inspiration and full expiration. The patients were radiographed in the usual standing position, anterior surface of chest to the film, in order that results could be more easily compared with previous pictures. It was found that most patients in that position showed a tendency to straighten up during inspiration, thus bringing the chest higher on the film than at expiration. In fact in some cases this was so marked that the outline of the diaphragm appeared in a higher position on the film at full inspiration than at full expiration. That this was due to a

* From the Department of Photography, Norwich State Sanatorium.

† Read at the 1935 convention of the Biological Photographic Association.

motion upward of the entire chest was made clear by the lack of register of the clavicles and upper vertebrae, the discrepancy amounting at times to nearly two inches.

Taking two separate films obviated this difficulty, for no matter how the patient moved, the pulmonary fields could always be brought to exact superimposition by registering with reference to bony structure not affected by respiration. The two separate films also obviated the indefiniteness of outline, due to superimposition of shadows, as these could be slightly retouched or outlined for emphasis before the films were superimposed. Each of these two radiographic films should be much lighter and softer than the average chest film, their subsequent superimposition of necessity resulting in a composite of much greater contrast.

A spirographic record was obtained simultaneously with the making of the x-ray exposures, the resulting graph representing the amount of pulmonary air displaced between the exposures. After satisfactory x-ray film and spirographic records were obtained, each film was treated so as to emphasize the outline of the thorax and lobes. First the thoracic cage was outlined with India Ink, starting at the apex and continuing along the inner border of the ribs to the diaphragm, then the diaphragmatic shadow followed. This was done by means of a continuous line on the full inspiration film and of a broken line on the one taken at full expiration. The mediastinal limits were not outlined, as they were usually very indistinct and of little value for our study. The borders of the lungs were next outlined by means of a greased pencil (china-marking pencil, red or black can be used) in the same manner, following the interlobar fissures whenever they were visible. In some cases, multiple adhesions, or a small amount of fluid made necessary a rather diagramatic outlining rather than a very accurate one.

The films were then superimposed and registered. Ease and accuracy of registration were assured by making reference marks on each film. Very satisfactory anatomical landmarks for this purpose are the lateral processes of the vertebrae. Lines were drawn with a grease pencil following the outline of the lateral processes of the 1st dorsal vertebra, and of the distal edge of one of the lower vertebra—the lowest one which could be distinctly seen through the viscera. The edge of the process of the 1st vertebra was used to register along the axis parallel to the spine, and that of the lower one for the direction perpendicular

to it. These reference marks were made on each film; the films superimposed, registered, and stapled together at their upper margins, after which the marks were wiped off.

Arrows were then drawn with India Ink upon the film to indicate the direction and extent of the motion of the various anatomical parts, the head of the arrow pointing to the position at full inspiration. These assisted greatly in the visualization of the positional changes which had occurred. A tracing of the spirographic record was then made, with India ink on celluloid, (a piece of undeveloped but fixed x-ray film answers the purpose very well) disregarding the scale marks, which were traced separately on another piece of celluloid. This scale was used for all the spirographic records.

The spirographic tracing and the scale were then superimposed, taking care that the lowest part of the tracing representing full inspiration was even with the zero line, that the edges of the celluloid scale were marked on the tracing and the latter cut so that when the two were superimposed edge to edge, the tracing would automatically be in its proper relative position to the scale. Scale and tracing were then superimposed on the previously prepared x-ray films in such a position that they would not mar the lung fields, namely, under the heart shadow. This was done on a view box, and the composite was then photographed on a 5″ x 7″ film.

This last operation is the most critical one, and the one of greatest interest to the photographer. The emulsion employed, as well as the developing technique, must be capable of rendering all the necessary details. X-ray films vary markedly in contrast and density. No matter how good the taking and processing technique employed in the x-ray department, individual characteristics of patients will markedly affect the results. This is particularly true in pneumothorax cases, as the degree of pulmonary collapse markedly affects the contrast of the finished radiogram. Eastman Commercial Ortho or Commercial Panchromatic, or emulsions of similar gamma will be satisfactory for most reproductions. Contrast can be controlled to a marked degree by varying exposure and development. In extreme cases, Process films for very thin or soft x-rays, or Portrait films for very contrasty ones, should be used. The finished negative should be such that the India Ink markings are slightly but definitely more transparent than the densest part of the superimposed radiographs.

A source of light of constant emission is a great help in obtaining the best possible negatives. To compensate for fluctuations in the electric current supply, a rheostat and voltmeter should be used to regulate the voltage of the current supplied to the light source.

Under-exposure should be avoided. If an exposure which gives the proper value in the lightest part of the negative tends to burn out the densest part, a softer emulsion or a shorter development should be used rather than a change of exposure. With Radiographic film of extreme contrast, a soft glycin developer[1] has proved very satisfactory. Normally, Eastman D-19 should be used. Development time can be varied from $3\frac{1}{2}$ minutes to 7 minutes at 65 degrees Fahr. for either developer. It will be found that a negative developed in Eastman D-19 for $3\frac{1}{2}$ minutes will have about the same quality as a negative developed in glycin for $6\frac{1}{2}$ minutes. These figures vary somewhat with the sensitive material employed and the number of films previously processed in each developer. In any case, the use of these two developers gives a wide range of contrast control. They can both be used over and over; their keeping quality is well over one month, if in a bottle or covered tank. It can be said in passing that the above remarks apply to any type of x-ray reproductions.

The appended illustrations show clearly the various steps of the method. In Figure 1 there is an unretouched reproduction of radiograph taken at full expiration; the lungs are well collapsed. There is an adhesion at the left apex.

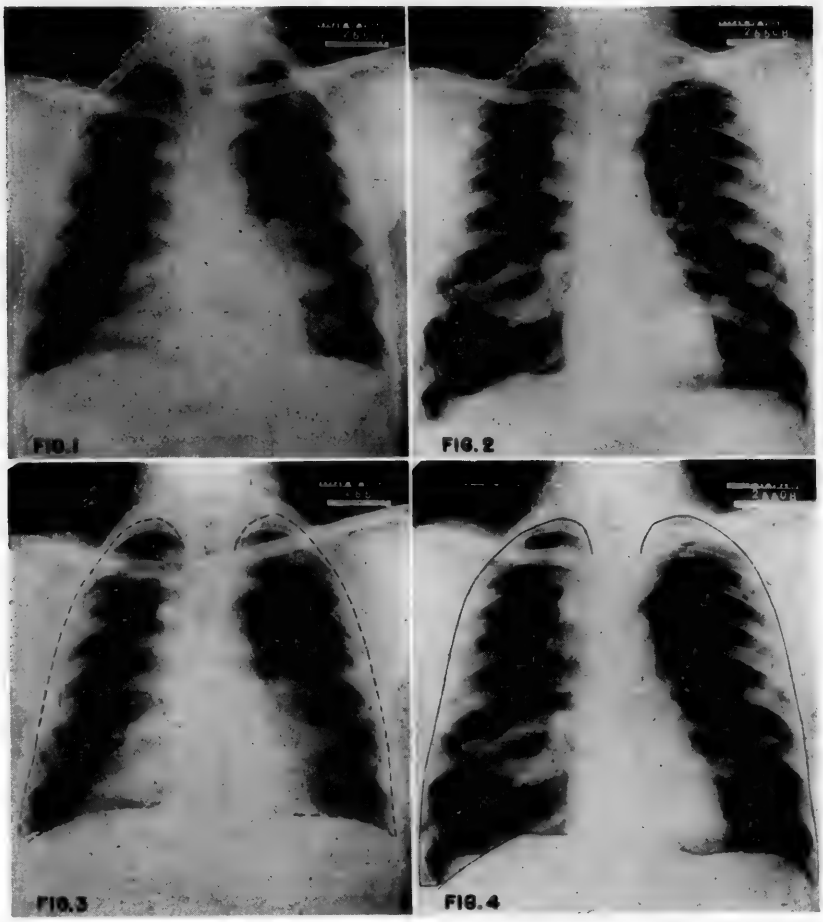
Figure 2 shows an unretouched reproduction of radiograph taken at full inspiration; lungs fairly well expanded; the lowering of the right diaphragm has uncovered some adhesions. In both this and the first picture all the outlines are distinct, though very faint in places.

Figures 3 and 4 are the same radiographs after the thoracic cage and diaphragm have been outlined with India Ink, and the pulmonary lobes with grease pencil. The outlining of the adhesion at the left apex and those at the right diaphragm has been done somewhat diagrammatically. Solid lines were used for the full inspiration film, dotted lines for the one taken at full expiration.

In Figure 5 we see a composite reproduction of radiographs used for Figures 1 and 2, before any outlining, but after they have been superimposed in register by means of the grease pencil marks A and B.

[1] Sodium sulphite desic., 75 grams; glycin, 30 grams; sodium carbonate desic., 150 grams; and warm water (140°F.), 3600 ml.

The appearance is similar to a film obtained by making the two radiographic exposures successively on one film. Parts of the lung outlines have been lost and the expiratory diaphragmatic shadow practically obliterated; the multiplicity of pulmonary shadows at the right base



precludes any decision regarding the phase of respiration to which they belong.

Figure 6 is a composite reproduction of the outlined films reproduced as Figures 3 and 4. All outlines are still visible and can be definitely

assigned to their proper respiratory phase; arrows have been added to indicate more clearly that relationship. The spirographic record and its scale were also photographed with the superimposed radiographs. In this case the pulmonary motions indicated by the arrows caused the displacement of 1.9 liters of pulmonary air.

In Figure 7 we see the final composite reproduction. The negative used for Figure 6 has been retouched, the pulmonary borders being further emphasized with pencil, resulting in a thin dark band which assures that no necessary outline will be lost in half-tone reproduction.

The making of prints or transparencies or lantern slides from these negatives does not present any unusual problem. It has been our

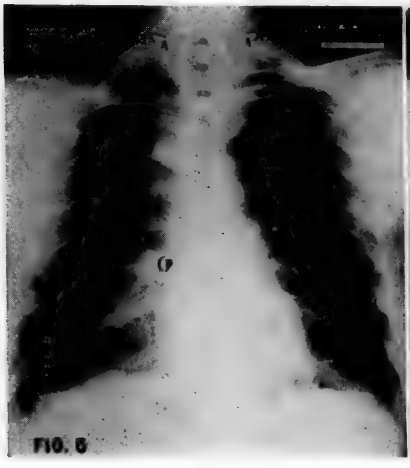


FIG. 6

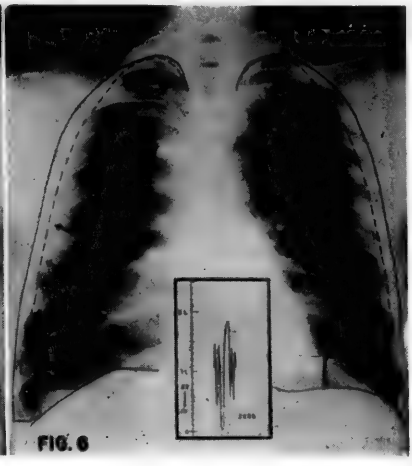
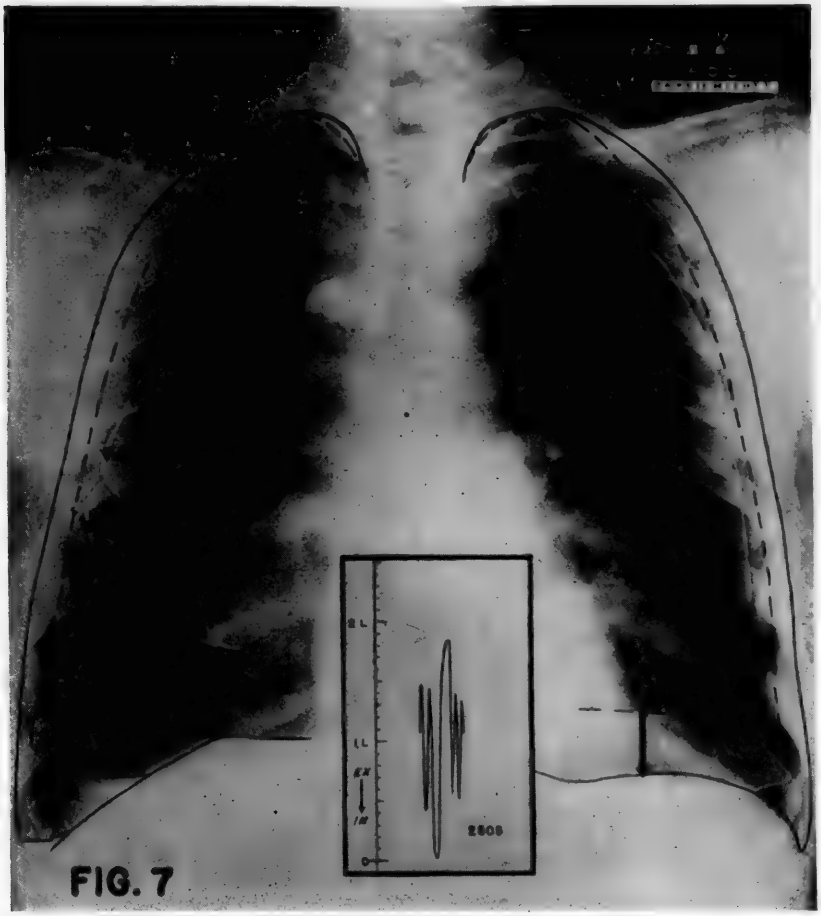


FIG. 6

practice with all lantern slides of radiograms to print and develop them slightly darker than usual; then, after partial washing, we clear them by slight reduction in Farmer's reducer. This procedure adds much to the brilliancy of the slide.

The thickness of the arrows used to indicate the direction and the extent of motion was our greatest source of trouble. At first we used a line about 1 mm. thick on a 14″ x 17″ x-ray film. This looked very well on the 5″ x 7″ negative, 5″ x 7″ or larger transparencies, and even on the lantern slide reproduction when examined in the hand. However, on projection, it was found that these arrows were practically lost when viewed from the middle of the average auditorium or further, particularly

when they were against a dense portion of the composite radiograph. A line about 2 mm. wide should be used on a 14″ x 17″ x-ray film to be reduced to lantern slide size; 1 mm. would be satisfactory for 8″ x 10″ or smaller films. The lines used for outlining the thoracic cage or diaphragm should not cause any trouble, as they are much longer.



In work of this type close coöperation between the radiographic and photographic departments is essential. It has been my privilege to work out this method with the coöperation of Dr. William H. Weidman, our Radiologist, whose valuable criticisms and advice have had a great

part in its development, and of Dr. Hugh B. Campbell, our Superintendent, who suggested this study, and whose encouragement and help have made its success possible.

PRINT CRITICISM

LEONARD A. JULIN

Rochester, Minn.

A number of our readers have expressed the wish that this journal establish a print criticism feature in which would be presented a picture of inferior quality together with a better photograph of the same subject, and with a description of the technic used in arriving at the improved results.

Figure 1a is a photograph made of a specimen to show scarring produced by a duodenal ulcer at the point indicated by the glass rod. The specimen had been fixed and the surface was blotted dry before the exposure was made. The negative was on Commercial Ortho film, and the exposure was 45 sec. at f:32. The source of light was a Halldorson lamp having five 500 Watt bulbs behind a diffusing screen of tracing cloth. The print was made on #2 Azo paper.

Figure 1b is another photograph of the same subject after the edges had been trimmed to give it a neater outline. To better demonstrate the lesion the specimen was spread out and fastened to the background with common pins, the visible parts of which were then cut off. The background consisted of cardboard on cork-board. The camera was moved closer to the specimen to obtain more magnification of the lesion. An exposure of one minute with the same light and diaphragm opening as used for Fig. 1a was given. The same type of film was used, and the developer in both instances was Eastman D-11. The print was made on Azo F. #2 paper.

FIG. 1a

FIG. 1b

PHOTOGRAPHIC TECHNIC, NEW PROCESSES AND EQUIPMENT*

F. R. HARDING

Boston, Mass.

SUGGESTIONS FOR ROUTINE METHODS IN ORTHOPEDIC CLINICAL PHOTOGRAPHY

If routine methods can be established for photographing orthopedic deformities they will be of assistance in follow up photographs of the same patient. They will also be an aid in comparing different patients having the same diagnosis.

Adults can be photographed to scale, but children cannot, due to rapid growth, orthopedic cases often requiring several years to complete the course of operations and treatment. If the picture area is filled by a two year old child, and the same child is returned for a second photograph at the age of four, it is obvious that if scale photography is applied, either the child will have to be photographed on a larger film at the second visit, or the head or feet will be eliminated from the photograph.

The following are a few of the routines employed at the hospital with which the writer is connected:

For club foot records, both feet and legs from the knees down, are photographed in the anterior and posterior position, bearing the weight of the body if possible. In addition, a lateral view is sometimes required.

Cases of bow legs and knock knees are photographed in the anterior and lateral positions. The lateral view shows whether or not anterior or posterior bowing is present. The photographs include the hips, legs and feet.

Torticollis is photographed in the anterior and posterior positions. The head and trunk are included, and the patient poses standing. The standing position is stressed, because when the patient is seated, a one sided body tilt is sometimes apparent which presents a false shoulder line.

Dislocated hips are usually posed to show positive or negative Trendelenberg signs, with the posterior superior spine marked, so as to show the pelvic tilt more readily. For a unilateral dislocation three views are made, one lateral view to show any lordosis present, and two posterior views. One of the latter is made with weight bearing equally upon both

* From the Department of Photography, Children's Hospital.

feet, and the other with weight bearing only on the affected leg, the other leg being flexed at the knee. No upward force should be applied when the knee is flexed for the femur may raise, and a false sign will result. Care should be taken that the pelvis does not twist while the latter view is being made.

Four full length views are made for scoliosis records. They are anterior, lateral, posterior, and posterior in the forward bending position. The latter is to show the maximum rotation of the spine. This point is most easily found if the attendant will place a finger on the point of maximum rotation while the patient slowly raises or lowers the back in response to directions from the operator, who watches on the ground glass of the camera until all of the attendant's finger shows at the high point of the spine. Without the finger in place it is very easy to pass the maximum point without realizing the fact.

The few examples described will serve to show how routine methods can be employed.

Under no circumstances should a follow up photograph be attempted until the prints or negatives of the previous visit have been consulted. Observe the lighting, background and size of the figure. Duplicate them them on the follow up negatives. If this is done there will be no cause for a complaint that the figures of a series of views of the same patient do not match in size. A variation of one quarter inch is the maximum which should be allowed.

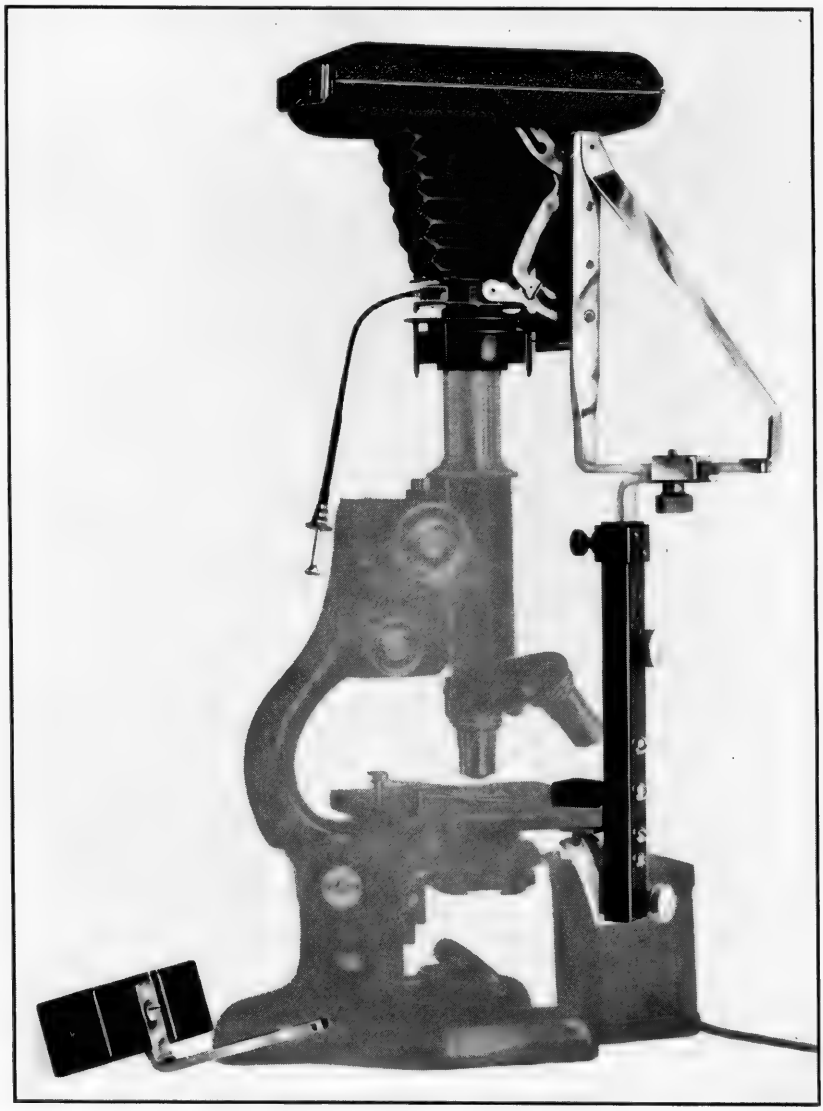
Close up views of clinical subjects can be carried to extremes. Enough of the subject should be included so that there will be no doubt as to what part of the body is being photographed. If this is not possible, another view should be made as a companion to the extreme close up, which will show a larger area, including some landmark by which the part of the body may be identified.

PHOTOMICROGRAPHY SIMPLIFIED BY NEW MICRODAK

The Eastman Kodak Company announces the new Microdak which makes it possible for any user of a microscope to make photographic records of his work without more than a casual knowledge of amateur photography.

It is only necessary to focus the subject under the microscope properly, to place the Microdak in position and to operate the shutter. Because the camera uses roll film, no darkroom is required, so photomicrographs can be made in any schoolroom or office. After exposure in the Microdak, the film can be developed and printed by any regular photo finisher or by the microscopist himself.

The Microdak consists of a camera using $2\frac{1}{4}''$ x $3\frac{1}{4}''$ roll film, and having a fixed focus lens and a shutter with provisions for bulb and time exposures; a light-lock to



shield the microscope eyepiece and camera lens; a bracket for holding the camera, a support for the camera and bracket, which fastens to the stage of the microscope; and a counterweight that attaches to the microscope base.

In making photomicrographs with a Microdak, the subject is illuminated and the microscope focused in the usual way, with a relaxed eye. The light lock then is placed over the eye-piece and the camera so located that the lens will assume the position occupied by the eye in focusing. Finally, an exposure of proper length is made and the photomicrograph has been recorded.

BELL & HOWELL ANNOUNCES 8 MM. CAMERA

The Bell & Howell Company has announced that it will have an 8 mm. motion picture camera in production within a few weeks. Samples are now being distributed among dealers. More than three years of engineering development, Bell & Howell report, have preceded this announcement.

The new camera is known as the Filmo Straight Eight. It uses a new film, Bell & Howell Filmopan, a fine-grain reversible panchromatic film which is presplit and packed for daylight loading on spools containing 30 feet of usable film plus 2 feet for loading and unloading. This film costs only $1.45 per spool, and so provides an attractively low operating cost for the new camera.

Small size, light weight, provisions for extremely simple loading and operating, and the scientific design and Bell & Howell precision construction which make for fine picture results and a long life of dependable service are other advantages emphasized in the manufacturer's announcement of the new 8 mm. camera. The weight is only 24 ounces; the size is $1\frac{3}{8}$ by 3 by 5 inches.

The camera is easily and quickly loaded. There are no sprockets to thread, no film loops to form. The film spools are placed on the spindles—they cannot be placed there other than correctly—and the camera is loaded! When the permanently-attached hinged door of the camera is opened, the film gate springs open, ready to receive the film. The gate is closed by the shutting of the door. The footage dial is automatically reset to 0 when 30 feet of film have been exposed, and, as it is inoperative when the camera door is open, need never be reset by hand.

A $12\frac{1}{2}$ mm. F:2.5 anastigmat lens in universal focus mount is standard equipment. Its graduations extend through 180°, making for easy setting. Extra lenses to be available later include: 1-inch F:2.7, $1\frac{1}{2}$-inch F 4.5, and the same three focal lengths in larger apertures. Filmo 70 and 75 Camera lenses will later be adaptable to the 8 mm. camera.

Lens interchangeability is made quick and easy by a spring lock. One merely presses two knobs together to release or replace the lens.

There are four speeds—8, 16, 24, and 32 frames per second.

Winding is easy and silent by means of a permanently-attached, non-rotating key that folds flat against the side of the camera. The spring motor is automatically stopped well before exhaustion of its power, to prevent loss of speed at the end of the run. There is also means to prevent the end of the film from leaving the gate after the film is all exposed. This insures the film's remaining tightly wound on the spool, so that it will not be fogged when the camera door is opened for unloading.

Spyglass viewfinder and built-in exposure calculator are standard features.

Rock-steady 8 mm. pictures can be obtained, under present film perforation tolerances, only by having the camera which takes them and the projector which shows

them matched, one with the other, as to the method of film registration at the aperture. This all-important matching is fully accomplished in the Filmo Eight Camera and Projector. Both use the same film perforation for the pull-down, and the same film edge for side guiding. In both, the side guides and the side tension springs are of the same size and location. These provisions minimize any unsteadiness caused by film perforation and film width variations.

The Filmo 8 mm. Camera is finished in rich brown crinkle-baked enamel with black and plated fittings. It has a sturdy die-cast aluminum-alloy housing.

Filmopan film for this new 8 mm. camera is processed, without additional charge, in New York, Chicago, Kansas City, and Los Angeles and in stations in most countries outside the United States.

INFRA-RED PHOTOGRAPHY USING THE EASTMAN INFRA-RED SENSITIVE PLATE, TYPE 1R

The infra-red is that portion of the spectrum of radiation which lies beyond the visible red. It is invisible to the human eye, and merges into the long heat waves. Infra-red radiation is emitted by all the common light sources which depend for their action on materials being raised to a high temperature, such as the sun, the arc lamp, the common tungsten filament lamp, and the lamps of the Photoflash type. These are all satisfactory sources of infra-red. The lamps emitting so-termed "cold light," such as the mercury vapor tube, are not very satisfactory for the production of the infra-red.

Infra-red photographs have been made since the latter part of last century, but it was not until 1931 that sensitizing dyes were produced which enabled photographs to be taken in the infra-red with the ease with which ordinary pictures are taken. With the *Eastman Infra-red Sensitive Plate, Type 1R*, photography by these invisible rays is very simple, requiring no more experience than ordinary photography. This plate is sensitive to violet and blue light and to the invisible rays beyond a wavelength of 700mu, with a maximum sensitivity at 820mu. It does not respond to the visible green and red light.

Any ordinary plate camera may be used for taking infra-red pictures, and any lens may be employed. Most lenses give pictures in focus in the infra-red if they are focussed correctly for visible light. If good focus cannot be obtained, the camera should be focussed visually through a red filter. In very exceptional cases it may be desirable to focus by making trial exposures at various settings of the focusing scale.

In the case of some older cameras, the bellows may transmit infra-red and fog the plate. This may also occur with some hard rubber drawslides, which are transparent to infra-red. The material used for making the bellows of Kodak cameras, however, in quite safe. The hard rubber used in 5 x 7 and 8 x 10 Eastman darkslides having five dots embossed on the metal tops is also safe. Metal, Pressboard and Composition slides are perfectly satisfactory.

In making photographs by infra-red, it is necessary to prevent violet and blue light reaching the plate. This is done by using a deep yellow or red filter over the camera lens (or over the lamps). The following Wratten filters are all equally satisfactory: Wratten filter No. 15 (G), No. 25 (A), No. 70, No. 89-A, and No. 88-A.

The same exposures will be required through all these filters. The filter most commonly used is the Wratten No. 25, tricolor-red (A) filter.

Infra-red Landscape Photography

The most common use of the Eastman Infra-red Sensitive Plate, Type 1R, is for landscape photography over long distances.

When a distant landscape is photographed on an ordinary plate, the detail of the distance is usually blurred by the haze, and the distant objects are rendered as if seen through a finely ground glass. This is because violet and blue light, to which an ordinary plate is sensitive, is scattered by atmospheric haze. The longer wavelengths of visible light, and particularly the invisible infra-red, however, are transmitted quite freely by the haze. An infra-red photograph, taken with a deep yellow or red filter on the lens to absorb the blurring violet and blue can, therefore, render distant objects very sharply, even if the haze makes them invisible to the eye.

Suitable exposure conditions for an open landscape in bright sunlight are about 1/10 second at f:4.5 (or 1/2 second at f:11 with the Wratten No. 25 filter on the lens, and the Eastman Infra-red Sensitive Plate, Type 1R. Exposure meters are of no value in judging infra-red exposures. The actual value depends on atmospheric conditions, and must be judged by experience, but the figure given will apply in most cases.

Infra-red landscape photographs are characterized by the sky being rendered almost as black, clouds and snow are white, shadows are very dense and lack detail, and the grass and leaves of trees appear very light as if covered by snow, because chlorophyll has the property of reflecting infra-red very strongly. Photographs taken by infra-red outdoors in sunlight often have the appearance of pictures taken by moonlight.

Infra-red Portraits

Infra-red photographs can be taken indoors using ordinary Mazda lamps, Photoflood lamps, or Photoflash lamps.

Suitable conditions are: Eastman Infra-red Sensitive Plates, Type 1R; Wratten No. 25 filter; subject illuminated by two Kodaflectors (4 Photoflood lamps); exposure 1 second at f:11. Four Photoflash lamps in reflectors are also satisfactory as light source.

In portraits by infra-red, the flesh appears chalky, the red lips come out light, the eyes appear as black dots, and all lines in the face are greatly exaggerated.

Photographs in Total Darkness

If a filter which transmits no visible light but freely lets through the infra-red is used over the lamps, pictures may be made in total darkness. No filter is used over the lens, and care must be taken to ensure that no white light leaks from the lamp housing. A suitable filter for the lamps is the Wratten No. 87, which is specially made in 10″ x 12″ and 8″ x 10″ sizes in the same form as safelights.

A convenient arrangement is two pairs of 500-watt lamps (or Photoflood lamps) in reflectors, covered with the Wratten No. 87 filter. With the units at about six feet from the subject, the exposure is about 3 seconds at f:4.5.

Special Uses

Infra-red photographs of old documents, fabrics, etc., may yield results of interest. If the subject is illuminated by two Photoflood lamps in reflectors, placed about 30 inches apart and 30 inches from it, the exposure will be about 2 seconds at f:16.

Infra-red photographs of the skin may be of value to the medical profession in studying skin diseases. They also show up quite clearly the superficial veinous system. The Eastman Clinical Camera and two Kodalites or Kodaflectors may be used.

Photomicrographs of certain subjects made by infra-red rays sometimes show interesting characteristics. In general, there is no advantage in photographing thin stained sections by infra-red. Some rather opaque insect specimens, however, show details of internal structure when photographed by the infra-red which are not visible in ordinary photomicrographs. The following may serve as a guide to the exposure:

Head of blow-fly: Infra-red Sensitive Plate, Type 1R; Wratten No. 25 filter; 48 mm. Micro Tessar; f:5.6; exposure 3 minutes; 18 amp. arc; mag. × 15.

Photographs of hot bodies, such as a flatiron or soldering iron, may be made in total darkness using the invisible infra-red emitted by the object. No filter need be used on the lens if the object is not white hot. A hot electric flatiron can be photographed in this way in about five to ten minutes at f:4.5 on the Type 1R plate. At temperatures below 400°C., the exposures are very long, about 12 hours at f:4.5 being required at 330°C. If the plates are hypersensitized the exposure is reduced to one-half or one-third.

Development. For the development of the Eastman Infra-red Sensitive Plates, Type 1R, any negative developer can be used. The D-76 and the D-19 developers are specially recommended. For negatives of normal contrast the best results are obtained with D-76, developing 15 minutes at 65°F. If a shorter development time is desired, the D-19 developer can be used, normal contrast being given in 5 minutes at 65°F. by the developer diluted 1 part with 4 parts of water. For negatives of high contrast, it is used undiluted for 3 to 4 minutes at 65°F.

The D-76 developer is obtainable in package form in sizes to make 1 quart and upwards. The Eastman X-ray Developing Powders, obtainable in package form are roughly equivalent to the D-19 developer.

D-76 Developer Formula

	Avoirdupois	*Metric*
Water (about 125°F.) (52°C.)	24 ozs.	750.0 cc.
Elon	29 grains	2.0 gms.
Sodium sulphite, desiccated (E. K. Co.)	3 ozs., 145 grains	100.0 gms.
Hydroquinone	73 grains	5.0 gms.
Borax	29 grains	2.0 gms.
Cold water to make	32 ozs.	1.0 liter

Dissolve the chemicals in the order given. For normal contrast, develop 15 minutes at 65°F. (18°C.).

D-19 Developer Formula

	Avoirdupois	*Metric*
Water (about 125°F.) (52°C.)	16 ozs.	500.0 cc.
Elon	32 grains	2.2 gms.
Sodium sulphite, desiccated (E. K. Co.)	3 ozs., 90 grains	96.0 gms.
Hydroquinone	128 grains	8.8 gms.

Sodium carbonate, desiccated (E. K. Co.)	1 ozs., 265 grains	48.0 gms.
Potassium Bromide	75 grains	5.0 gms.
Cold water to make	32 ozs.	1.0 liter

For high contrast, the developer should be used without dilution for 3 to 4 minutes at 65°F. (18°C.). For normal contrast, dilute 1 part of the developer with 4 parts of water and develop for 5 minutes at 65°F. (18°C.).

Safelights. The plates should be developed in total darkness or with care by the light of the Wratten Safelight, Series No. 3.

Hypersensitizing. The speed of Infra-red Sensitive Plates, Type 1R, can be increased about three times by hypersensitizing. For the best results in hypersensitizing, the plates should be bathed in a 4 per cent solution of ammonia made by diluting 4 parts of 28 per cent ammonia (the strongest available commercially) to 100 parts with water. This solution should be used at a temperature not exceeding 50°F., and bathing should be for about 1 minute. The plates should be dried as rapidly as possible, preferably using an electric fan. The operations should be carried out in total darkness.

Care must be exercised in hypersensitizing, or streaks may result, and in drying particular care must be taken to prevent dust from blowing on the plates, otherwise spots will occur.

Storage. Infra-red Sensitive Plates, Type 1R, will keep for many months under normal conditions of storage, although like all photographic materials they keep best if cold. If they are kept in an icebox or refrigerator they should be removed several hours before they are used, and allowed to warm up to the temperature of the room before removing from the box. Otherwise, dew may form on them and give rise to markings.

THE PRESIDENT'S ADDRESS

What Value Lantern Slide Projection?*†

LOUIS SCHMIDT

New York, N. Y.

In my opinion the President's annual message should include a presentation of some subject that is of real interest to our members and to those we serve. It should point the way to methods of technical improvement in routine work and call attention to some conditions that they may help to improve.

Last year my predecessor, Mr. Creer, presented a review and criticism

* Read at the 1935 Convention of the Biological Photographic Association.

† From the Division of Illustration, Rockefeller Institute for Medical Research.

of the quality of photographic illustrations in the medical journals, which aroused much comment. I propose to review the making and projection of lantern slides as we find them in the lecture room and at scientific meetings. The lantern slide is so small a thing that we sometimes forget its importance. Though it is small in size, its projected image is far bigger than our bromide enlargements. We must, therefore, constantly keep the projected image in mind in everything we do in the making of a slide, or in its projection. Every defect is greatly exaggerated. Pin holes, spots, faulty placement, bad alignment, and carelessly cut mats all contribute to poor results on the screen.

The output of a photographic division usually consists of photographs made for illustrations in publications, for display, and for records, as well as specifically for making lantern slides. From negatives in the first group slides are also made. They are important in the class room and as adjuncts to the presentation of papers at scientific meetings. They constitute a large fraction of the total output of the division. The slides made from pictorial material and from photomicrographs give satisfactory results on the screen, when the photography is technically good and the projection up to standard. But even in this group greater care in the selection and study of the material, before the negative is made, would pay big dividends in the superiority of the final results. Especially is this true in the case of photomicrography. Here the careful study of the microscopic slide, in order to combine in one picture the greatest number of interesting points, or in the location of the very best example of some particular object, is of paramount importance. If the entire negative is to be included in the lantern slide, great care should be exercised to place the point of interest in just the right location in the negative.

Observation at many scientific meetings and in various auditoriums has convinced me that a large percentage of lantern slides made from printed or typed pages, drawn graphs and diagrams are very disappointing, and sometimes quite useless, when projected. The faults are manifold. Often the photographer is asked to include too much material to produce an image on the screen that is readable beyond the center of the hall. There is often included too much reading matter for the audience to perceive and understand in the short time that the image is on the screen. It is claimed by some that, in spite of poor readability, such slides are useful to the speaker as reminders, and to the observer to show

trends, if not definite details. However, such slides do tire the audience and distract, rather than hold their attention.

An abstract containing 20 per cent of the matter would usually give all the important facts and could be read and understood without the nervous strain caused by trying to assimilate too many statements. Sometimes the audience becomes bored and inattentive because of its inability to absorb the too complicated tables, and as a result the presentation suffers. We should also point out that many statistical compilations or graphs, which, when printed in a journal, may be very satisfactory because the reader has ample time to analyze all their details, may be useless when projected on the screen for a short time. The average person can fully understand only one word per second.

In the preparation of graphs, which our clients often work out in pencil on cross-section paper to be inked in by the artist or secretary, the selection of the correct paper and ink is important. When the printed lines on the paper are merely to be an aid in calculating the table and are not to be included in the photographic print or in the lantern slide, it is best to select a paper with pale blue lines. Such lines are the most easily eliminated by the photographer. When the graph is worked out on cross-section paper only to serve as a guide for the artist who will prick the points through to the cardboard on which he is to draw, then any colored lines will serve. If, however, the cross-section lines are to remain a part of the print or lantern slide, it is best to use lines of black, orange, green, or red.

The photographer should utilize all the available space on the slide, as the loss of a quarter of an inch may mean the loss of a foot on the screen. He should also ask the typist to have the copy occupy a space in the proportion of 11″ high by 12″ wide. Thus it would fill all of the space on the slide, viz.: $2\frac{3}{4}$″ by 3″.

No photographic copy can be better than the original from which it is made. The typing should be clean, sharp, and black, on white paper. If possible the lines dividing the columns should be drawn in with a ruling pen and black india ink rather than be printed on the typewriter.

Projection. In almost all motion picture theatres this matter has been very carefully studied and in most of them the projection is excellent. They have provided screens large enough so that details are visible everywhere. The projection apparatus is equipped with a lens that completely fills the screen and with a light source that delivers a brilliant

picture. In the lecture and class rooms where some of these conditions are lacking, the lantern presentations are quite inferior, and sometimes slight changes produce very great improvement.

As the correct sequence of slides is of paramount importance, it is recommended that they be numbered on the cover glass with a diamond or grease pencil in such a way that it will not show in projection. This is particularly desirable when the slides are in more than one box, as an error in the sequence of the boxes would be disastrous.

Lenses and condensers must be clean, and the lamp on the reading desk should be arranged so that none of its light falls on the screen. It is well to test the lantern with a full-size slide to make sure that the light completely covers the screen. Needless to say, the screen must be taut and not movable by currents of air in the room. The lantern should be tested as to proper centering of the light before the audience is present, as the screen when filled with glaring light, is very unpleasant and annoy, ing. The auditorium should never be in total darkness. The first slide should be projected before the lights in the room are dimmed and the last should remain until the auditorium is fully illuminated. Always have an extra light bulb in reserve. The lantern should never be at an angle to the screen.

Our members should investigate the projection conditions in their institutions, and in locations where their slides are to be projected, and make every effort to have their slides meet the conditions. Too much white margin around a slide is very hard on the eyes and should be avoided.

Before preparing slides to be used in a nearby city, a set of lantern slides made from the same negative was sent for a test in the ampitheatre where they were to be used. The slides contained 40, 22, and 15 lines respectively. The test made by a local member of the B. P. A. proved that the 22 line slide was readable to the last row of seats and the series made on that basis gave perfect results. Ascertaining this fact may appear to have been a good deal of trouble, but it was justified by the results and by the satisfaction of the speaker. Such a procedure may be used if time permits, and the presentation is in a hospital or school, but not if it is in a hotel.

When slides are sent out from a photographic studio, they should be immaculately clean, for on the screen fine detail is often degraded by finger marks. Usually the speaker must assume the blame for this. In

preparing his lecture he sometimes handles his slides, not as does the photographer only along the edges, but as he would a deck of cards. If then they are handed to the lantern operator just before the speaker goes on the platform, there is no time left to clean them. Why not, as a matter of routine, put into each box of lantern slide we release a slip of paper reading:

NOTICE

"These slides are clean. In handling it is best to touch them only at the edges; or if fingers touch the surfaces, it should only be near the edges, where the mask will prevent finger marks from showing. They should be checked for finger marks before being handed to the lantern operator, or returned to this department for cleaning before use in projection."

Name and address of photographic department

The author attended a meeting in one of the most modern medical centers and found an ampitheatre with a projection screen about twice as wide as its height. Its size was quite inadequate to the size of the room. The projected image of a full-sized slide did not come within two feet of the top of the screen and many slides were unreadable. After the first session it was pointed out to the secretary that if the lantern were moved back two rows of seats, the image would fill the height of the screen. By this simple change projection was improved 25 per cent.

The matter of having lanterns equipped with adapters to carry foreign sizes of slides is important where such slides are likely to be used; nor may we nowadays ignore the miniature camera slides which sometimes come as strips and other times as small, individual slides. For these special projectors or attachments are indicated.

Many scientific meetings are now held in hotels where different groups use large or small ball rooms. Often they are supplied with lanterns and screens, bed sheets, etc. that are inadequate to each other and to the room. Speakers who have carefully prepared their material and paid handsomely for good slides are bitterly disappointed with their presentation; or viewing their tables at short range, they are unaware that half of their audience cannot see a word.

This would seem to indicate that hotels that cater to societies for conventions would do well to equip their rooms with properly balanced projection apparatus and screens, which should be selected with regard for safety and optical requirements. A proper rental charge for the use of

such equipment would make the investment a source of profit to the hotel and a great satisfaction to its clients. The secretaries of the various societies should impress this upon the hotel managers where they propose to hold their meetings.

Always keep the projectors in your care in perfect condition. See that the filaments of the bulb, and the bulb itself, are in proper position and relation to the condensing lenses to give the best results.

DISCUSSION

President Schmidt's address on "What Price Lantern Slide Projection" created an active discussion. Many members described their experiences at medical meetings, where they had seen valuable papers spoiled by poor slides; or had been asked to show good slides with inadequate equipment. It was the consensus of opinion that the slide that does not tell its story clearly; is not legible; or cannot be easily seen, is a very real detriment to the speaker's paper. Such slides distract the listener's attention, and are considerably worse than no picture at all.

Mr. Clarke suggested that Mr. Schmidt's paper should appear in the publications of the hotel associations. It should also reach the secretaries of scientific societies. These secretaries should know the minimum of equipment to demand from the hotel or society to ensure satisfactory projection at meetings of various sizes. Other members agreed, and urged that the manufacturers of projection equipment should also be given reprints of the article.

All present felt that the betterment of lantern slide quality and lantern slide projection was an important work for the Association to undertake.

Association News

ARTHUR W. FUCHS

Rochester, N. Y.

FIFTH ANNUAL MEETING

In the white and gold ballrooms of the Stevens Hotel, Chicago, from September 12th to the 14th convened the *Fifth Annual Convention* of this Association.

To those who were not there, let it be said that a lively interest in the proceedings was in evidence the entire time. The technical exhibit and the Second Traveling Salon were conveniently placed in a room adjoining the assembly room. Many members of the Association were represented in the exhibit, and they are to be complimented upon the fine quality of work which was on display on all sides. We were very glad to have another contribution sent by Dr. Silvertr Prat from Czecho-Slovakia.

As registration took place, it was a pleasure to meet face-to-face, many of the Chicago and Western members who previously had not had an opportunity to meet with the Association. Of course, there were many familiar faces which have been seen at every meeting since the inception of the Association.

Members were again actively interested in the possibilities of infra-red photography and many were the new, interesting facts brought to light regarding this new medical diagnostic medium.

A new innovation was the showing of a series of interesting medical and biological 16 mm. motion pictures, on Thursday night. These films were collected for the occasion by the Motion Picture Committee and Mr. Creer. Such films as Dr. DeLee's, *The Art and Science of Obstetrics*, Arthur Hinman's, *A Motion Picture Study of the Larynx*, D. Robert Rugh's film, *Ovulation, Egg Transport and Fertilization in the Frog*, and Professor Lester G. Barth's *Development of the Fish Egg*, were greatly enjoyed. The last two films were made in the Zoological Department of Columbia University and photographed by Jack Godrich, New York City. A very interesting x-ray motion picture sent by Dr. Russell Reynolds of London, showed the result of his experiments with x-ray cinematography employing the fluorescent screen. The film shown consisted of an endless strip projected over and over of the action of a human heart.

Mr. Martinson gave an interesting talk on the growth of the Chicago Chapter. This new unit of the Association has done much during the period of its existence to bring to its members interesting and valuable educational programs.

The following officers were elected to administer the Association for the coming year:

President	Mr. Louis Schmidt
Vice President	Mr. Leonard Julin

Secretary..... Miss Anne Shiras
Treasurer..... Miss Stella Zimmer

Especially do we wish to thank Mr. Williamson for the splendid manner in which he planned and carried out the staging of the exhibition of prints without expense to the Association. His interest in this exhibit was in direct relation to his ideas on the subject of the dissemination of medical knowledge which he feels depends a great deal upon photographs.

Mr. J. A. Bledsoe, Department of Zoology, University of Cincinnati, Cincinnati, Ohio, has volunteered to assume the task of routing the two Traveling Salons. All inquiries regarding these exhibits should be addressed to him.

Mr. Kieffer suggested during the meeting that besides exhibiting technical pictures, every member should bring along prints showing what other type of photography he was most interested in as a hobby. The hobby exhibit would have to be limited to three prints apiece. The number of these prints that would be hung would depend largely upon the amount of space left over from the regular exhibition.

An amendment to the constitution was passed which now permits all applications for membership in the Association to carry two endorsements as to the ability and character of the applicant. Before this change in the constitution was effected, it was necessary for a new applicant to submit two letters of recommendation. It is felt that this amendment will do much toward facilitating the acquisition of new members. An addition to the constitution creating a *sustaining membership* also was made which requires that $10 per year be paid by the member instead of the usual amount required. Any sustaining member may revert to ordinary membership at will. The first to acquire a *sustaining* membership were Mr. Louis Schmidt and Miss Anne Shiras.

The Committee on Awards, consisting of Messrs. Julin, Martinson and Zieler, worked with great zeal and patience on a very difficult problem. This committee has since the meeting submitted a very comprehensive report making valuable suggestions for improvements in future exhibitions.

The banquet was the high point in the meeting. We were very fortunate to have Dr. Morris Fishbein, Editor of *The Journal of the American Medical Association* and Dr. Malcolm MacEachern, Associate Director of the American College of Surgeons, as guest speakers. Dr. Fishbein spoke interestingly concerning the value of photography in the realm of science and medicine. The gist of his talk may be found in an editorial which appeared in the September 28, 1935, number of *The Journal of the American Medical Association*. Everyone attending this affair enjoyed himself and later gathered into groups to spend very pleasant evenings.

No decision as to the meeting place for the convention in 1936 was made. However, it was suggested that either Boston or Buffalo be chosen.

The Association extends its thanks to the following firms for their cordial and practical coöperation: Eastman Kodak Company, The Bell & Howell Company, E. Leitz, Inc., Bausch & Lomb Optical Company, Hammer Dry Plate Company, The General Electric X-ray Corporation, Burton Manufacturing Company, Inc.

A résumé of the program follows:

President's Address—"What Value Lantern Slide Projection?" Mr. Louis Schmidt.

"Intragastric Photography." Dr. Paul E. Thal.
"Photography of Cavities." Mr. Ralph P. Creer.
"Photo-Engraving, as Applied to Biological Photography." Mr. E. G. Karth.
"Design in Medical Illustrating." Mr. Tom Jones.
"Further Developments in Infra-red Photography." Mr. Leo Massopust.
"Ocular Photography." Mr. R. W. Bennett.
"The Making of Color Prints by the Carter-Reeve Process." Messrs. Carter and Reeve.
"Surgical Motion Pictures with the Kodachrome Process." Mr. Harris B. Tuttle.
"Photomicrography with Polarized Light, Its Principles and Applications." Miss Thelma Baird.
"Surgical Photography with a Miniature Camera." Mr. W. R. Williamson.
"Comments on Miniature Photography." Mr. W. H. Zieler.
"Simple Cinemicrography." Mr. R. Fawn Mitchell.
"Illumination for Low Power Photomicrography." Mr. Roger P. Loveland.
"An Improved Method for Recording Pulmonary Motions." Mr. Jean Kieffer.

* * * *

The Chicago Chapter of the Association met October 1st at the Fort Dearborn Camera Club to hear a talk by Mr. W. H. Zieler of E. Leitz & Company on *Practical Photomicrography.*

* * * *

In a recent paper, *Chorionepithelioma in the Male,* by Drs. H. C. Fortner and S. E. Owen, may be found some good examples of clinical photography by Mr. Creer. This paper appeared in *The American Journal of Cancer,* 25: 89–97, Sept. 1935.

* * * *

An interesting paper by Dr. Edgar Jones on *The Demonstration of Collateral Venous Circulation in the Abdominal Wall by Means of Infra-Red Photography* appeared in the October, 1935, number of *The Journal of Medical Sciences.*

* * * *

The Second Traveling Salon will be hung at the New York Academy of Medicine during the month of November.

A. W. Fuchs.

THE BIOLOGICAL PHOTOGRAPHIC ASSOCIATION, NEW YORK CHAPTER

The season of 1934–35 was most successful for the New York Chapter of the Association. During the autumn of 1934 the more active members of the Association met with representatives of the four large optical manufacturers and prepared a plan of action designed to bring new life to the local chapter. The results were even better than had been anticipated. In February the Association met at Rockefeller Institute for the first of the meetings under the new order. Mr. L. Paul Flory was installed as the new president of the local chapter after which under the able direction of our national president, Mr. Louis Schmidt, the methods used in the Rockefeller photographic department were fully explained.

The second meeting in March was held at the Washington Square College of New York University. Mr. Roy M. Allen gave a most interesting talk on the subject of photomicrography, illustrated with lantern slides. While all of the slides exhibited extremely good technique, the point which aroused the greatest interest was the method of optical sectioning which retained full sharpness without much blur. Mr. Allen explained that by the proper combination of optical elements and illumination, the plane of focus was made so sharp with such rapid diffusion on both sides, that the results shown had been made possible.

The April meeting was held in the show rooms of Bausch & Lomb Optical Co. in New York City. Mr. Ernest H. Anthes gave an address upon the history of the microscope which was received with hearty approval. Mr. Anthes showed that the mechanical development of the microscope embodied relatively few new ideas, as most of them had been used years ago, but that modern advances had been made primarily in the optical fields. After the address the members of the Association spent some time in examining the various Bausch & Lomb instruments which were on display, most of them in operation.

The last meeting of the season was in May when Dr. White of the DuPont Research Laboratories gave an address upon the technical use of infra-red in photography. The facts presented were most welcome to our members as many of us had been working with the infra-red material without fully understanding it. That there are many important uses of infra-red in clinical work cannot be denied, nor is its use limited to this. Mr. Flory presented some interesting examples of the use of infra-red photography in botanical research.

After the summer was over, the first meeting of the 1935–36 season was held in the show rooms of E. Leitz, Inc., of New York. The president of the firm, Mr. Wolfgang Ziehler, presented an interesting address upon the relationship of illumination to microscopy and photomicrography. He brought out the fact that for a few years the different methods of illumination were restricted to different fields of microscopy. Polarized light for the mineralogist, direct (vertical) illumination for the metallographer, transmitted light for the biologist and so forth, the darkfield being given a restricted use by the bacteriologist. He then pointed out that today, by using modern equipment, each of these forms of illumination could be used to good advantage by the biologist, and even to a certain degree by all microscopists.

Following the address the members of the Association were shown a complete exhibition of Leitz scientific instruments, many of which were set up for display. Under Mr. Ziehler's guidance the chapter members were enabled to see a practical demonstration of the points brought out in the address.

Mr. Ziehler as chairman of the Program committee, aided by the efforts of Mr. Flory and Mr. Irving Banner of Eimer and Amend have made the meetings of the local chapter events to be looked forward to by the members. This is no doubt responsible for the present chapter membership of more than seventy, and the rapidly growing interest in biological photography.

* * * *

Herbert C. McKay, the secretary of the New York chapter of the Biological Photographic Association, has conducted a radio program every week for the past

four months. The program is designed to encourage greater interest in photography and to teach the public more of the importance of photography than is commonly known.

Mr. McKay, who is a Fellow of the Royal Photographic Society, and instructor and writer in the field of photography, has presented a broadcast which has sufficient drama to hold the interest of the average broadcast listener, while presenting photographic facts of interest. The drama is made possible through a complete cast of actors who present dramatized camera adventures both preceding and following the more technical moments of the program. Each week prominent guests are featured including the best known camera workers of the United States.

B. P. A. PRINT EXHIBIT

1935 Awards

Class		*Prize*	*Awarded to*	
1a, 1b, 2a	No awards			
2b	Oral cavity	1st	Dr. Mendelsohn	Print designated
2b	Oral cavity	2nd	Mr. Creer	Photo of tonsil
2c	Eye	1st	Mr. Marfaing	Set of 6 lat. views
		2nd	Mr. Creer	
2d	Eye (fundus)	2nd	Dr. Bennett	
3	Skin lesion	1st	Mr. Creer	Lesion on forearm
		2nd	Mr. Clarke	T. B. lesion on hand
4	Specimen	1st	Mr. Haulenbeeck	Heart and lungs
		2nd	Miss Baird	Cross-section anatomy
		3rd	Mr. Clarke	Stomach
5	Technic	3rd	Mr. Williamson	
6	Apparatus	1st	Mr. Schmidt	Lindbergh pump
		2nd	Mr. Clarke	Cataphoresis apparatus
		3rd	Mr. Williamson	
7	No awards			
8	Slides (color)	1st	Mr. Kieffer	Group of slides
9a, 9b	No awards			
9c	Fish	1st	Mr. Tutell	Print designated
10	No awards			
11ai	Cultures, ×1	2nd	Mr. Clarke	Photo of tubes
		3rd	Mr. Haulenbeeck	Two plates
11aii	Cultures, ×3 and up	1st	Mr. Schmidt	Group of prints
		2nd	Mr. Kieffer	Group of prints
11b, 11c	No awards			
11d	Plants	3rd	Mr. Carlile	Print designated
11e	Animals	2nd	Mr. Tutell	Penguins
12, 13, 14ai	No awards			
14aii, 14bi	No awards			

Class		*Prize*	*Awarded to*	
14bii	Blood cells	1st	Miss Zimmer	Group of prints
14c	All magnifications	1st	Mr. Schmidt	Group of prints
14d	No awards			
14e	Wood sections	1st	Dr. Prat	Entire group of prints
15	No awards			
16	Infra-red	1st	Mr. Massopust	Group of prints
		2nd	Mr. Creer	Two pairs of prints
17	Transparencies	1st	Mr. Kieffer	
		2nd	Mr. Massopust	

Judges: Mr. Julin,
Mr. Zieler,
Mr. Martinson.

Book Reviews and Abstracts

C. V. NEBLETTE

Rochester, N. Y.

"Photomicrography." 13th Edition. Eastman Kodak Co., Rochester, N. Y. $1.00.

While the primary purpose of this book is aptly stated in its sub-title, "an introduction to photography with the microscope," it is much more than an introduction to its subject, and in its 122 pages it includes a good deal of material which will be of interest even to those well versed in photomicrography.

While the present edition (13th) contains much of the material found in its predecessors—revised and brought up-to-date—several sections are either wholly new or have been so thoroughly re-written as to be practically new. This is true, for example, of the section on low power photomicrography which has been expanded from a short paragraph to 4½ pages. Likewise the section which in previous editions was termed "Photomicrography of Opaque Objects" is now designated as "Photomicrography by Incident Illumination" and has been more than doubled in extent and is much more complete than heretofore. The various methods of illumination are discussed briefly but thoroughly, and attention is called to the use of the newly introduced polarizing screens for controlling the reflections which often make it difficult to secure good results in work of this kind.

Other sections new to the present volume include the making of three-color negatives for photomicrographs in color, motion photomicrography in color using the Kodachrome process, and the determination of the necessary aperture and selection of the objective.

An enlarged bibliography and good index complete a very useful book.

"Practical Amateur Photography." William S. Davis. Little, Brown & Co., Boston. $2.25.

This is a new edition of the work first published in 1923, and includes three new chapters: Amateur Cinematography, Color Photography, and Miniature Cameras.

The aim of the author as stated in the foreword is "to provide a general guide book for amateur photographers, in which is described in proper sequence each step in the evolution of a finished photograph; the theoretical ground work as well as the practical working details being given. . . ."

The book is based largely upon the author's experience—perhaps a trifle too much to be as complete as might be desired—and the chapters on "The Case of Pictures vs. Records," "Figures and Animals," "Landscapes as a Source of Inspiration," "Ships and the Sea," and "Architecture, Street Scenes, Flower and Still Life Subjects" are especially good.

A list of well chosen references at the end of each chapter enhance the value of the book.

"The Photography of Colored Objects." 13th Edition. Eastman Kodak Co., 1935. Price $1.00.

The 13th edition of this well-known text on the use of color sensitive materials and filters has been brought out, handsomely bound in imitation leather. In general, the subject matter is the same as in the previous edition, but there are many changes here and there throughout the text which bring the book thoroughly up to the minute. It is a book which the serious photographer cannot well do without.

"Die Microphotographic mit Infraroten Strahlen im Dienste der Zellforschung. Protoplasma." S. Prat, and K. Hruby. Verlag von Gebruder Borntraeger in Leipzig. 1934. Vol. 22, Part 1.

Describes the methods of infra-red photomicrography employed by the authors at the Institute for Plant Physiology, Karls University, Prague, in the investigation of the physiology of plants. Contains an excellent bibliography of the subject.

The Journal of the Biological Photographic Association

Official Publication of the Biological Photographic Association

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March, 1936

PUBLISHED QUARTERLY BY THE WILLIAMS & WILKINS COMPANY
MOUNT ROYAL AND GUILFORD AVES., BALTIMORE, U. S. A.

Journal of the
Biological Photographic Association

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Entered as second class matter March 15, 1933, at the Post Office at Baltimore, Maryland, under the Act of March 3, 187
Made in the United States of America

VOLUME IV *March, 1936* NUMBER 3

The Journal of the
Biological Photographic
Association

COLOR PRINTS ON PAPER*†

MERRILL W. SEYMOUR

Rochester, N. Y.

The general utility of color photographs on paper is so great that every biological photographer will want to master one of the available processes for this purpose. It must, of course, be a process which can produce results of technical excellence, both in the rendering of color and in the depicting of fine detail. While such a process must require skill and care, the amount of time and labor consumed and the dependability of results are, of course, to be considered. A survey of a few of the more widely used processes of proved reliability is therefore desirable.

The processes described all require a set of three color separation negatives through suitable red, green, and blue filters. If possible, these are made directly from the subject. This is readily done, if the subject is an inanimate one, by successive exposures with an ordinary camera. If the subject is living, but capable of holding a pose for limited periods, there are repeating backs and various forms of repeating cameras that are useful in making three exposures in rapid succession. If the subject is apt to move, the exposures must be made simultaneously in order that the three images shall be identical except for color values. This requirement is met by the use of one-shot cameras, in which optical devices divide the beam, and also by the use of screen plates and screen films. With one-shot cameras, the three negatives are obtained directly from

*From the Research Laboratories, Eastman Kodak Company.
†Received for publication November 6, 1935.

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the subject, but with screen materials, the negatives must be obtained from the screen positive or negative by exposures onto panchromatic materials through red, green, and blue filters with narrow transmission bands.

In making prints on paper from these negatives, the subtractive principle is employed for all commercially successful processes. While there have been attempts to make paper prints by additive methods similar to those used for screen plate transparencies, prints made by these methods are necessarily lacking either in luminosity or color saturation.

According to the subtractive principle, each of the separation negatives is printed as a positive in a dye or pigment which absorbs the primary color transmitted by the filter through which its own negative was exposed, but which absorbs as little as possible of any other color. The colors of the dyes or pigments are the colors which they do not absorb, but which they transmit or reflect, and are, therefore, complementary to the colors of the taking filters. Thus, the positive from the red filter negative is printed in blue-green, the positive from the green filter negative in magenta, and the positive from the blue filter negative in yellow. These three colored images, if properly made and superimposed in register upon a white paper support, will give a print in natural colors.

Although the various processes for paper prints have these fundamentals in common, they differ with respect to the particular materials and photographic and chemical steps employed.

The pigment process is one of the oldest, and, from a chemical point of view, one of the simplest processes by which color prints on paper can be made. Nevertheless, it is capable of making prints of technical excellence, beauty, and permanence. This process is frequently called the carbon process because, in the early application of the pigment process to black and white photographic printing, carbon was the pigment most used. For color photography, however, pigments of the three subtractive printing colors are required. Each pigment is incorporated in gelatin and is usually coated on paper forming pigment tissue or carbon tissue. The gelatin is rendered light-sensitive by bathing it in a solution of a bichromate and drying it in the absence of strong light. Each tissue is then exposed for several minutes in contact with the proper separation negative. The light source may be the sun, an arc lamp, or a powerful tungsten filament lamp. Where the sensitized gelatin is

struck by light, more or less of the bichromate is reduced to a chromic salt which combines with the gelatin, rendering it insoluble in warm water. If the pigmented gelatin had been coated upon a transparent support and the exposure had been made through this support, all that would be necessary to render the image visible would be to immerse the film in warm water for a short time, whereupon the soluble gelatin would dissolve, leaving a relief image in pigmented gelatin adhering to the support. Since, however, the pigment layer is coated on paper, it must be exposed from above. Consequently, the insoluble image lies in the upper surface. If the exposed tissue were placed directly in warm water, the underlying gelatin would dissolve, leaving the image to float away and disintegrate in the water. For this reason, the pigment tissue must first be washed in cold water and squeegeed with its gelatin side in contact with another support. In the three-color carbon process, this second support is a temporary support, and consists of Kodaloid or similar transparent film, the surface of which has been waxed and polished. The sandwich so formed is then placed in warm water until the unexposed gelatin has melted, whereupon the paper backing of the tissue is stripped away. By this means, the relief image is obtained adhering to the second support. The process of developing the image on a second support is called the carbon transfer process. The images so obtained are positive pigment images, since the gelatin at every point contains more or less pigment in proportion to its thickness.

The pigment images in three colors must now be transferred, one at a time and in superposition, from their temporary supports to a single sheet of gelatin-coated white paper. The entire process, including this step, is called the double transfer process.

The second transfer is effected by squeegeeing the temporary support, image side down, onto the gelatin side of the wetted paper, allowing the sandwich to dry, and then stripping the temporary support from the paper, to which the pigmented relief image now adheres. After the first image has been transferred, the second and third are laid down in a similar manner in register with the first. The wax that was orginally applied to the surface of the temporary support aids in this transfer. When the three pigment images have been superimposed upon the final paper support, the print is finished.

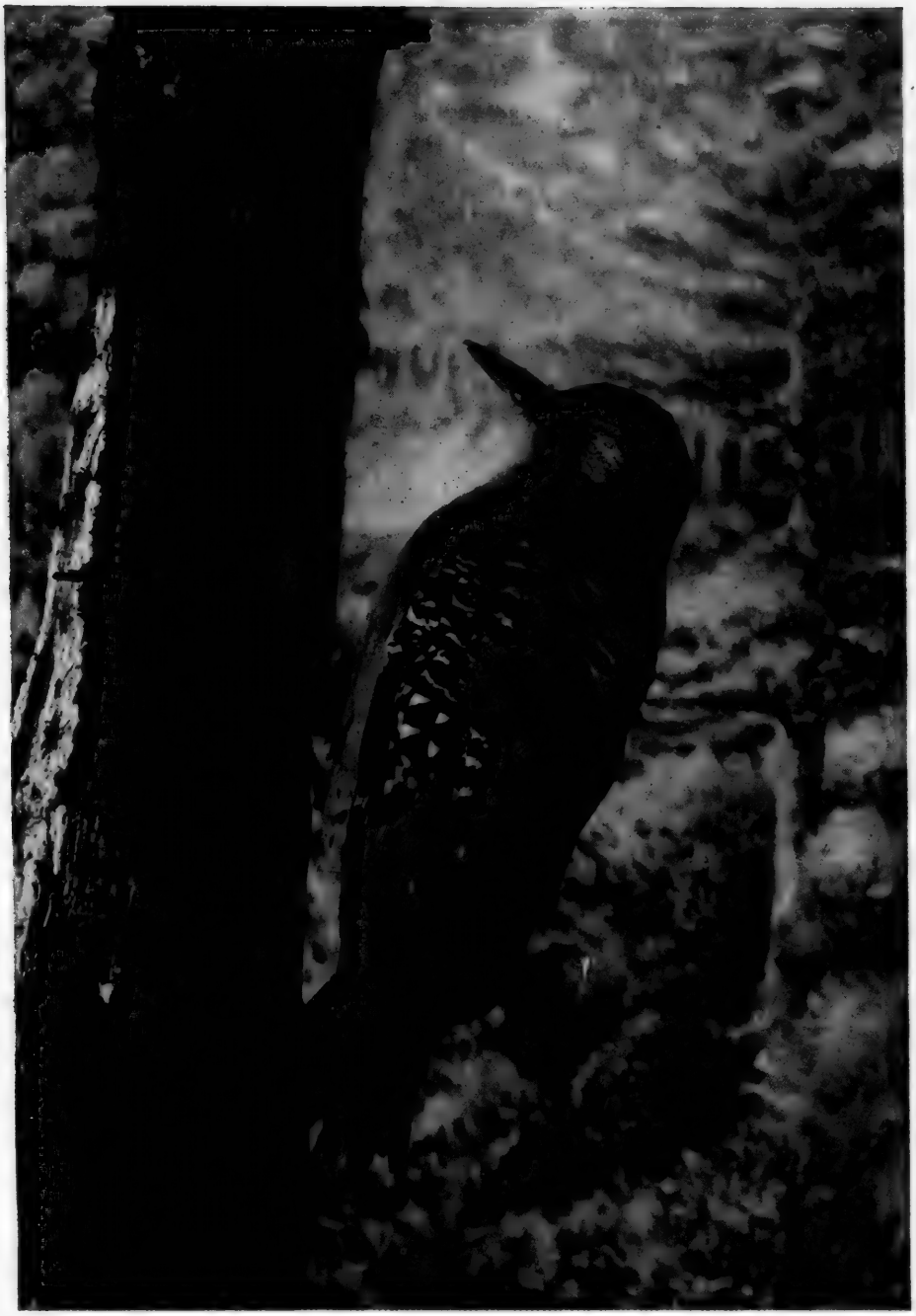
Although excellent results are obtained by the three-color carbon or pigment process, it suffers the obvious disadvantage of requiring very

long printing exposures to powerful light sources. The making of enlargements is practically excluded, except by the indirect process of first making an enlarged negative.

On account of the long exposures required and the practical impossibility of making direct enlargements, the three color carbon or pigment process has largely been superseded by the three-color Carbro process. This process, as its name implies, is a sort of hybrid of the carbon process and the bromide printing process. To be more specific, the three negatives are printed, by contact or enlargement, onto bromide papers. These are developed and fixed. Tissues of the variety used in the carbon process are then soaked in a solution containing a bichromate, potassium bromide, an acid, and either potassium ferricyanide or copper sulphate. These are then squeegeed onto the three bromide prints. In a few minutes of contact, the silver images are converted to silver bromide by the oxidizing action of the bichromate, which is thereby reduced to a chromic salt. This chromic salt produces an insoluble image in the layer of pigmented gelatin in contact with the silver image, just as the chromic salt, produced by the direct action of light in the carbon process also gives rise to an insoluble image. The pigment tissues are now stripped entirely from the bromide prints and squeegeed onto transparent temporary supports. The relief images are developed in warm water as in the carbon transfer process. Finally, the pigmented reliefs are transferred in superposition to paper support by stripping them from the temporary supports.

It is not obvious however, how the silver image on the bromide paper can effect the reduction of the bichromate in another layer, especially since the chromic salt forms an insoluble complex with the gelatin, and therefore cannot wander. This effect is due to the presence in the bleaching solution of a soluble substance capable of being reduced by the silver and oxidized by the bichromate in a reversible manner. Either copper ions or ferricyanide ions fulfill these requirements.

These ions diffuse from the soaked tissue into the emulsion layer on the bromide paper. Here, they are reduced by the silver image (ferricyanide ions to ferrocyanide, or cupric ions to cuprous). Their reduction products then diffuse in all directions, some of them entering the carbro tissue, carrying the reducing power of the silver image to the bichromate in the pigmented gelatin. The distance to which these ferrocyanide or cuprous ions can diffuse before reacting with the bichro-



Color Separation Negatives by A. K. Wittmer from Specimen in Rochester Museum.
Three-Color Photo-Engraving—No Black Plate Used.
Photographic Color Correction by the Eastman Kodak Company's Masking Method plus a Small Proportion of Hand Work.

mate depends upon the relative concentrations of these ions and of the bichromate ions. Locally, this ratio depends upon the density of the silver image which is being attacked. Generally, it depends upon the relative concentrations of ferricyanide and bichromate originally present in the bleaching solution. The higher the proportion of ferricyanide, therefore, the higher will be the relief image, and the higher will be the gamma of the pigment image.

Although the conditions affecting the quality of the Carbro image are rather complex, it has been possible to determine empirical rules for controlling the results by varying the composition of the bleach bath. Some workers prefer to divide the components of the bleach into two solutions, in which the tissues are bathed successively for varying lengths of time before squeegeeing them onto the bromides.

The Carbro process is employed by a number of professional illustration photographers with excellent results. It is also employed by Colour Photographs Limited of London, England, who offer a regular commercial finishing service. Some of the recent improvements in the Carbro process have been made by this company and are protected by patents. The chief difficulty in the use of the Carbro process on a small scale is the very precise control required, not only in the time of the photographic operations and the temperature and composition of the solutions, but also in the temperature and humidity of the atmosphere in the work room. The same is true of the carbon process. An air-conditioned laboratory, with a refrigerating unit, is almost a necessity.

For the complete working instructions for the carbon and Carbro processes, reference should be made to good manuals on the subject, particularly the booklets of the Autotype Company, London, England. This company also sells the materials for these processes. The agent in the United States for this company is George Murphy, Inc., 57 East 9th Street, New York, N.Y.

There are a number of other processes for printing on paper which depend upon the ability of reduced bichromate to combine with gelatin and alter its solubility, or its ability to absorb water or certain dyes. One of these resembles Carbro insofar as it produces a gelatin relief image from a developed silver image. This is the Wash-Off Relief process, for which detailed instructions and the necessary materials have recently been made available by the Eastman Kodak Company.

In this process, a film bearing a yellow-dyed silver bromide emulsion

is printed from the support side with violet light. The film is developed, and then the silver image is submitted to a bichromate bleaching solution. The silver image is converted to one of silver halide, and the bichromate is simultaneously reduced to a chromic salt. It is obvious that the process differs from Carbro in that the insoluble image is formed in the same layer as the silver image. By a short treatment in warm water, the soluble gelatin and undeveloped silver bromide are washed away, leaving a gelatin relief image containing silver chloride adhering to the support. After removal of the silver halide with hypo, only the gelatin relief remains.

Relief positives made in this way from the three separation negatives are dyed with water-soluble dyes in the subtractive printing colors. The dyed reliefs are then squeegeed, one at a time, onto a wet sheet of mordanted, gelatin-coated paper. The resulting absorption of the dyes by the surface of the paper is called the imbibition transfer process. The color print so formed consists of a pure dye image on a colorless mordant.

The film upon which the positive reliefs are printed in this process is Eastman Wash-Off Relief film. The yellow dye in the emulsion is essential to the formation of a suitable relief image. This may be explained by considering an ordinary positive film emulsion which has a relatively low density to white light. If the film is exposed to white light and subsequently developed, although the lowest densities tend to lie more in the surface from which the exposure was made, a slight increase in exposure is enough to produce densities that are almost evenly distributed throughout the depth of the emulsion. A relief image produced from such a silver image with a bichromate bleach shows a very steep gradation and short latitude. If, however, the emulsion is heavily dyed, and the exposure is made solely with light of a color which the dye absorbs, the depth to which the exposing light penetrates effectively increases much more gradually with the intensity of the light. Accordingly, the silver densities extend to gradually increasing depths, and the corresponding gelatin relief image shows a gradual increase in thickness.

Since the emulsion used in Wash-Off Relief film is sensitive chiefly to blue and violet, a yellow dye is used to secure the desired gradation.

Where the exposure is heaviest, i.e., in the shadow portions of the positive, the blue-green light begins to be effective. Since this lies beyond the region absorbed by the yellow dye, it causes a more rapid increase of density in the shadow portions than in the highlight portions.

For this reason, a violet filter, Wratten No. 35, is used in the light beam to remove the green and blue-green rays and secure more accurate tone reproduction throughout the range of densities.

The exposure must, of course, be made through the support, in order that the relief image may remain on the film base instead of floating away in the warm water used for development. Since, however, the support is relatively thin, there is no difficulty in securing a sharp image in contact printing if a small light source is used at a fair distance from the negative. In enlarging, the aperture of the lens is sufficient to limit the beam.

Detailed working directions for this process are obtained by writing to the Eastman Kodak Company, Rochester, New York. The dyes for the relief images, suitable for imbibition transfer are sold by this company also. The working solutions, if carefully preserved against evaporation and contamination, may be used for dyeing a considerable number of relief films with imperceptible variation in the quality of successive prints. The same set of reliefs can also be redyed, after each imbibition print, in order to make duplicates at almost negligible cost.

The paper for receiving the imbibition print may be almost any variety of gelatin-coated or photographic paper—glossy, semi-matte, or matte. Excessively rough papers are preferably avoided, however, on account of the difficulty which may be encountered in securing good contact with the dyed relief during imbibition transfer. The paper is fixed out in advance and treated in an aluminum sulphate solution, followed by sodium acetate to buffer the acidity. After thorough washing, the paper is ready for use.

Some of the advantages of the Eastman Wash-Off Relief process are here summarized:

1. It facilitates printing either by contact or by direct enlargement.

2. The process is not sensitive to changes in the laboratory atmosphere so long as the solutions themselves are kept between reasonable limits of temperature.

3. The characteristics of the finished color print can be judged by superimposing the wet dyed relief films on a white surface. Slight errors in density or color balance can be corrected simply by rinsing the reliefs in water before transfer. Contrast can be controlled by altering the acidity of the dye solutions. In this way, a great deal of reprinting and waste of photographic material is spared.

4. Prints in pure dye images are obtained upon a variety of printing surfaces. These prints cannot peel apart and do not tend to curl appreciably more than black and white prints on the same paper. If a high gloss surface is desired, glossy paper is used, and the prints are dried on ferrotype tins in the usual way.

5. The prints are especially resistant to fading, the Eastman dyes having been selected from the most stable types made.

6. After making one satisfactory print, duplicates in considerable numbers can be made very cheaply.

Although the processes described do not exhaust the list of commercially available printing methods, they represent a group of related processes which have already had sufficient commercial use to prove their ability to meet high professional standards.

COLOR PRINTS BY THE CARTER-REEVE COLOR PROCESS*

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In the Carter-Reeve Color Process, as in much of the three color photography, three color separation negatives are made and printed in blue, red (Magenta), and yellow. The red and yellow sensitizers, instead of printing out, as in most processes, are bleached out. For this reason it is necessary to print the red and yellow images from positives. The blue image is made by the printing out process from the negative. The positives are made by contact printing or by projection onto plates or films. If the positives are made by projection it is necessary also to make a projected positive from the blue printing negative and then make a contact negative for the final blue print image. This method has the advantage of changing the contrast and density of the printing negatives and positives by taking advantage of the wide selection of emulsions on available plates and films. The positive should have all the detail of the negative from which it is printed and should be of medium contrast.

Briefly the details for making and combining the three color images are as follows:

* From the Department of Photography, Army Medical Museum.
Read at the 1935 Convention of the Biological Photographic Association.

Clean several pieces of glass, of the same size as the negatives to be printed. Old photographic plates may be used. Cellophane sheets (or other suitable material) are cut 1½″ to 2″ larger than the glass on which they are to be mounted. Immerse these sheets in a tray of clean water. Place one of the wet sheets on the glass with the edges protruding about equally on all four sides. Remove the water from between the cellophane and the glass with a flat squeegee and fold the protruding cellophane over the back surface of the glass. The edges may be best turned by folding back one side then the side opposite it. Squeegee these in place before folding the ends. Moisten the ends with mucilage or gelatin solution and fold them backward, squeegeeing to secure firm contact. Care should be exercised not to get any gelatin on the face of the cellophane which is to be sensitized as it may cause streaking in the finished image. The mounted cellophane sheets are dried on racks, in a few minutes, if placed in front of an electric fan.

The sensitizing material, developers and complete instructions for their use are available commercially. The blue image is made by moistening the surface of the cellophane on the glass with a small piece of cotton soaked in the blue sensitizer. Care should be taken to cover the surface thoroughly. The excess sensitizer that has not been absorbed by the cellophane is then sponged off with a larger piece of cotton. It should be wiped quite dry, but not rubbed hard enough to cause any wrinkles in the cellophane. When dry, place in a printing frame and print from the "A" or red filter negative. The frame should be larger than the negative to permit observation of the printing from time to time. A 11″ x 14″ printing frame serves very well for 8″ x 10″ prints. The emulsion side of the negative is placed in contact with the sensitized surface of the cellophane. The printing is done by exposure to sunlight, arc light or other strong artificial light as with printing out paper. The progress of the printing may be examined by inserting a piece of thin white paper between the mounted cellophane and the negative, examining of course, from the back of the frame. When sufficient detail has been printed the mounted cellophane is removed from the printing frame and washed in running water. The cellophane is removed from the glass support as soon as this can be done without tearing. This material will come loose more easily if the back corners are washed with warm water to soften the adhesive. As soon as the blue print is removed from the glass support it is immersed in a weak acid solution made by adding

10 drops of concentrated sulphuric acid to one quart of water. The blue print is left in this bath until ready for use.

The Red Sensitizer is applied to another cellophane sheet mounted on glass in the same manner as described for the blue sensitizer. The red image is printed from the "B" or Green filter positive. The red sensitizer bleaches out on being exposed to light. The progress of the printing is examined from time to time as described for the blue print. The printing is stopped when the highlights are clean. Remember that too much printing gives a weak image, and too little printing gives a strong image which is just the reverse effect of the blue print image. When the printing is complete the cellophane sheet while still mounted on the glass support is developed in the prepared red developer. The development is completed in from one to two minutes. When development is complete the red image is rinsed and removed from the glass support and placed in a special fixing solution or left in water until ready to use. The contrast of the red image is controlled largely by the contrast of the positive from which it is printed; however, a softer image can be made by diluting the sensitizer with plain water and printing for a shorter time. The contrast can be increased by using a strong solution of sensitizer and printing for a greater length of time. The red image can be reduced by the use of a weak solution of potassium permanganate.

The yellow image is made by sensitizing another of the glass mounted cellophane sheets with the yellow sensitizer as previously described. The yellow image is printed from the positive made from the "C" filter negative. The same method is followed for examining the progress of printing as given for the red image, as the yellow sensitizer also bleaches out instead of printing out. When the printing process is completed the yellow is developed in the prepared developer for yellow images, rinsed, removed from the glass support and placed in the prepared fixing solution for yellow. The contrast is controlled as described for the red, and the reduction of this image is also accomplished in the same manner as for the red.

The three images are now placed upon a white paper, cardboard or other suitable material, registered and studied for color values. If the print is correct it is mounted. If not, the images are separated and the proper one reduced to give the desired effect. This procedure may be repeated until the final print is obtained having the true relation of colors.

The final mount is made on a larger sheet of cellophane mounted on glass as previously described, usually a 14″ x 17″ sheet on a 11″ x 14″ glass is satisfactory. The cellophane sheet is coated with a gelatin solution. A second piece of cellophane is laid on the wet surface and squeegeed to secure even contact. This is allowed to dry. A piece of the backing paper furnished with the developers is soaked in water until quite limp then placed on the cellophane mount with the glossy side out using gelatin solution as a glue. Squeegee out any surplus gelatin and let dry. This forms the complete mount.

The color images are placed on the finished mount in the following sequence: yellow first, red second and the blue image last. The prepared mount is coated with the gelatin solution and the yellow image placed in position. The excess gelatin is squeegeed out and the preparation is placed in front of an electric fan long enough to set the gelatin. Coat again with a layer of gelatin and place the red image over the yellow being careful to secure exact registration. Set the gelatin by the use of the fan, and, after another coat of gelatin, place the blue image over the combined red and yellow images taking care to see that correct registration takes place. This completes the color print. It is allowed to dry, after which it is removed from the glass support by cutting around all four edges with a knife or sharp instrument just outside the 8″ x 10″ mount. The print can be attached to cardboard with dry mounting tissue if care is used to prevent overheating, or with rubber cement. The finished print can be spotted with water colors. A dull finish can be obtained by mounting a dull finish cellophane over the completed print.

DISCUSSION

Mr. Creer suggested that anyone interested in this process write to Mr. Reeve at the Army Medical Museum, Washington, D. C. He will send enough material for ten or fifteen 8″ x 10″ prints for about $30.00; this includes a set of working instructions, mounts and all items which the average photographer could not furnish himself.

In the open discussion, several members agreed that color work (even in the simpler transparency processes, such as Agfa and Finlay) requires practice and can only be successfully done by photographers who work at it steadily. An occasional picture will turn out very well for the inexpert color worker, but uniform results are only achieved by consistent work. The Carter-Reeves process and the Bell-Color Process, which

resembles it, depend largely upon good separation negatives. If the three original negatives are good, the experienced photographer can obtain a color print quite simply and quickly by either of these processes. Bromoil and Carbro demand more complicated processing room equipment. In either of these processes, the humidity and the temperature are so important that air-conditioning is practically essential in the processing room.

Mr. Kieffer suggested that any one who has time to experiment should try the new Eastman Imbibition Process, as it gives very excellent results.

KODACHROME AND ITS APPLICATION TO THE MEDICAL AND BIOLOGICAL SCIENCES*†

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Up until 1923 there had been only one or two attempts to promote sub-standard motion picture cameras, projectors, and film for the amateur. All efforts were unsuccessful. Those who could afford it made their pictures on standard 35 mm. film; but the excessive cost for the making of a single print, which was usually all that was needed, limited the making of personal films to a very few.

In 1923 the Eastman Kodak Company placed on the market a new sub-standard 16 mm. reversal film, with cameras and projectors for its use. The low price of these products popularized the personal movie idea overnight.

The film was developed by a reversal process, which, in short, converted the original negative image developed on the film into a positive image ready for projection, so that only one film was used. The film exposed in the camera, after development, became the film used in the projector.

The cost of development by reversal was paid for in the original purchase of film, so that there were no additional charges in order to obtain the projection print. This has become standard practice, and all types of Eastman amateur standard 8 and 16 mm. film are sold on this plan.

* Read at the 1935 Convention of the Biological Photographic Association.
† From Eastman Kodak Co.

Extensive use of amateur cameras, projectors, and film, and the subsequent improvements, reduced prices of both equipment and film. In 1923 only one type of 16 mm. movie film was available, an orthochromatic film, strongly blue-sensitive and only suitable for outdoor daylight pictures. In 1927 the Kodak Company placed 16 mm. panchromatic safety film on the market, which was sensitive to all colors, and gave true monochromatic rendition.

In 1928 Kodak announced to the world the first 16 mm. color process, Kodacolor. This color process has successfully served the amateur movie maker for the past seven years. It is capable of producing excellent results in color, but it has certain limitations which have halted its general adoption by all amateurs for all pictures. The minute lenses embossed in the base side of the film are visible on projection. Because a filter is used over the projection lens, the picture size is limited. These same filters, owing to their absorption of light, when used on the camera make it necessary to have, at the least, a strong hazy light for correct exposure. The camera lens must always be used at its maximum opening, and thus does not give much depth of focus. Objects out of focus produce multiple color fringes on projection.

In 1930 the Kodak Company announced 16 mm. supersensitive panchromatic film for amateur movie cameras. This film had twice the speed of panchromatic film to daylight, and about three times the speed of panchromatic to artificial tungsten light. About this time, the Photoflood lamp, an over-volted short-life Mazda lamp, was placed on the market, which, when used with supersensitive panchromatic film, made it possible to take pictures in the home at night, and under abnormal lighting conditions.

In 1932 an entirely new principle in amateur movies, an 8 mm. film, camera and projector, was placed before the public. The extremely low cost of 8 mm. equipment and film, and the wonderful results obtainable, have made it possible for practically everyone to enjoy the fun of making and showing his own personal movies.

Two years ago the Eastman Kodak Company announced a new 16 mm. movie camera, the Ciné-Kodak Special. This camera can do practically everything a professional 35 mm. camera can do—fades, dissolves, double-exposure, trick photography, slow motion and animation. It was demonstrated before the Association at the convention held in Rochester, New York.

Nearly every photographer since the invention of photography has dreamed of a day when it would be possible to make pictures in natural colors as easily as in black and white. There have been many processes of color photography invented, but all have been extremely complicated and necessitated the use of special cameras, filters and lenses.

An ideal color process would be one that could be used with any make of camera or projector, with any type of lens, regardless of the size of lens opening or focal length, and one where filters would be unnecessary on either camera or projector. The Kodachrome process recently announced by the Eastman Kodak Company fulfills all of these requirements. Anyone owning a 16 mm. camera and a 16 mm. projector can make and show personal movies in full natural color.

Fundamentally, the making of natural color pictures with Kodachrome film is no different from making pictures in black and white. The details of loading the camera and preparing the projector for use are identical with the standard procedure for black and white. In fact, Kodachrome film can be spliced into black and white reels and pictures projected alternately in monochrome or natural color.

For outdoor pictures Kodachrome film is slightly slower than panchromatic film. If the correct exposure for a scene in bright sunlight on panchromatic film were f:8, then the correct lens opening for Kodachrome would be f:5.6. It can be used through the full range of light conditions from cloudy dull to bright sunshine. Pictures can also be made indoors with suitable artificial light, such as Photoflood lamps used in the proper reflectors. However, to obtain true color rendition with artificial light, it is necessary to use a filter on the camera to adjust for the difference between the color of artificial light and the color of daylight. Since the color sensitivity of Kodachrome is balanced for sunlight, pictures made in artificial light without a compensating filter will appear a yellowish red when compared to pictures made by sunlight.

Pictures can be made with telephoto lenses or through a microscope; in fact, anything possible in black and white photography is possible on Kodachrome, such as slow motion pictures, speeded action, or any other type of trick photography.

The finished pictures can be shown on any make of projector and on practically any screen. Since there are no filters on the projector, there is no more absorption of light than in black and white photography and pictures can be enlarged on the screen to black and white size.

All color processes can be classified into two groups, namely, additive processes and subtractive processes. All of these processes have depended upon the division of light into three components, namely, red, green, and blue-violet. A color picture can be made by exposing three negatives of a subject, each one through a filter of one of these named colors. Positives must be made from each negative, then by projecting the three positives through the filters through which they were originally taken, and registering the three images, one upon the other, a colored image is produced. A process of this type is called an additive color process. The Kodacolor process mentioned earlier, which was announced in 1928, is an additive process. With Kodacolor, the color separation is obtained optically. In the lens of the camera is placed a multiple color filter containing vertical strips of red, green, and blue-violet glass. The minute lenses embossed in the base of the Kodacolor film make multiple images of the three filter units on the film emulsion. In projection, the same three filters are placed on the projection lens, and a multicolor image in the form of microscopic colored strips is projected and reproduces the colors of the original. With Kodacolor, or any additive processes, there is no color pigment in the film, the reproduction of color depending upon the filters used on both camera and projector.

In subtractive color processes, the camera or negative images are separated similarly to additive processes, but the final color print for projection is made by printing or dyeing the positives with colored pigments. These pigments are the complementary colors of the filters through which the originals were taken. For instance, the red filter positive is dyed blue-green, the green filter image is dyed magenta, and the blue filter image is dyed yellow. The new Kodachrome process is a subtractive process. The colors of the original subjects are visible in the finished positive.

The important point that makes Kodachrome different from all other color processes is the fact that instead of separating the color components side by side on the film, they are separated in the depth of the film. Kodachrome film is coated no less than five times! Nearest the base an emulsion is coated which is extremely red-sensitive. On this is a very thin coating of gelatine containing some dye for light filtration. On top of this is coated a second layer of emulsion which is strongly green-sensitive; over this is a second coating of gelatine, and finally, on the top, is coated an emulsion which is blue-sensitive.

Kodachrome film resembles a three-layer cake with the frosting left off the top layer. The three layers of emulsion are represented by the three layers of cake. The gelatine coatings between the bottom and middle, and between the middle and top are represented by the frosting. The frosting or gelatine coatings act as small fences and keep the emulsion sensitizers in each layer from straying away from their proper places. All five of these coatings combined are no thicker than the emulsion coating of an ordinary black and white film.

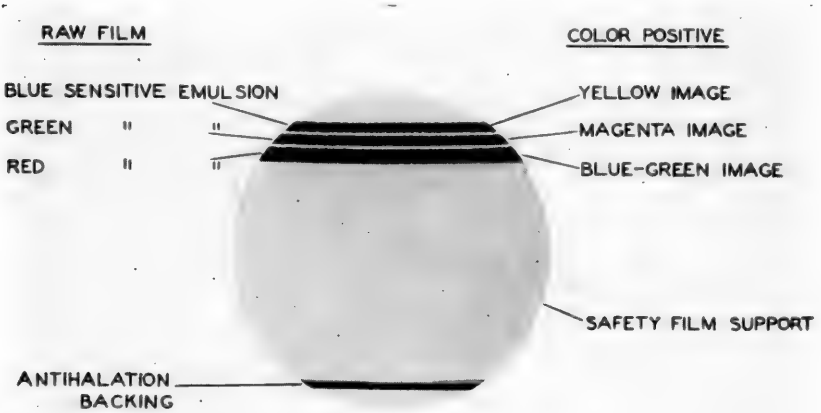

FIG. 1

The exposed film is developed by the reversal process used for the past twelve years for black and white 16 mm. photography. After developing Kodachrome film by the reversal process, the silver in each layer is converted into a dye image. The red-sensitive layer next to the film base is dyed blue-green, the second or green-sensitive layer is dyed magenta, and the top or blue-sensitive layer is dyed yellow. So the finished color images are perfectly registered one over another. Kodachrome film has been on the market only a few months, but already thousands of medical films have been made by doctors everywhere.

Since Kodachrome film is balanced for sunlight, pictures made with any other type of light will not give correct color rendition unless some

type of compensating filter is used. Inasmuch as the Photoflood lamp is universally available, low in cost and highly efficient, it has been arbitrarily selected as the artificial light standard. The Kodachrome artificial light filter renders much more satisfactory results with Photofloods than with regular tungsten. It can be used with regular tungsten, however, but the results are slightly reddish yellow when compared to Photoflood results.

The factor for this filter with artificial light is four times or two diaphragm stops larger. Since Kodachrome is one stop slower than panchromatic film, it is necessary when using Kodachrome with Photofloods and the artificial light filter to expose three stops larger than would be used for panchromatic film, or four and a half stops larger than would be used for supersensitive panchromatic film.

In case a light sensitive cell is used to measure the light, the above factors will serve as guides in determining the correct exposure. When using light meters in reading the intensity of artificial light, the meter should be held near enough to the subject when making the reading so that only light coming from the area being filmed will affect the meter. In making extreme close-ups this may mean holding the meter as close as six to twelve inches from the subject.

The high exposure factor for the artificial light filter is not at all serious, in filming gross specimens or making clinical records. Here more lamps can be used, or the available lamps placed closer to the subject, without any harmful results.

On certain operations such as in eye surgery where there is little danger of contaminating the wound, both lights and camera can be used fairly close to the operating field. On operations where the camera cannot be used at close range, telephoto lenses can be employed. Since such lenses work at smaller apertures ranging from f:3.5 to f:5.6, it is obvious that more light must be used with them to obtain sufficient exposure.

When making pictures, through the microscope, of stained sections, it is not necessary to use the artificial light filter. The differences in color might easily be less than the variation in stains. So the problem of lighting is practically the same as for black and white photography. However, pictures made with oil immersion must be brilliantly lighted, or the camera operated at fewer frames per second.

A number of doctors have made color films of surgical operations without the artificial light filter; and while this is not recommended,

some have been entirely satisfied with the results. Many of these men have used the artificial light filter over the projection lens when projecting these films. This is not recommended either, for the color rendition is only slightly modified when the filter is used in this way, whereas the colors are corrected by proper filtration when it is used on the camera.

In the reel of film shown at the convention the eye operation was made with one 500-watt 110-volt lamp in the Eastman Medical Spotlight, and

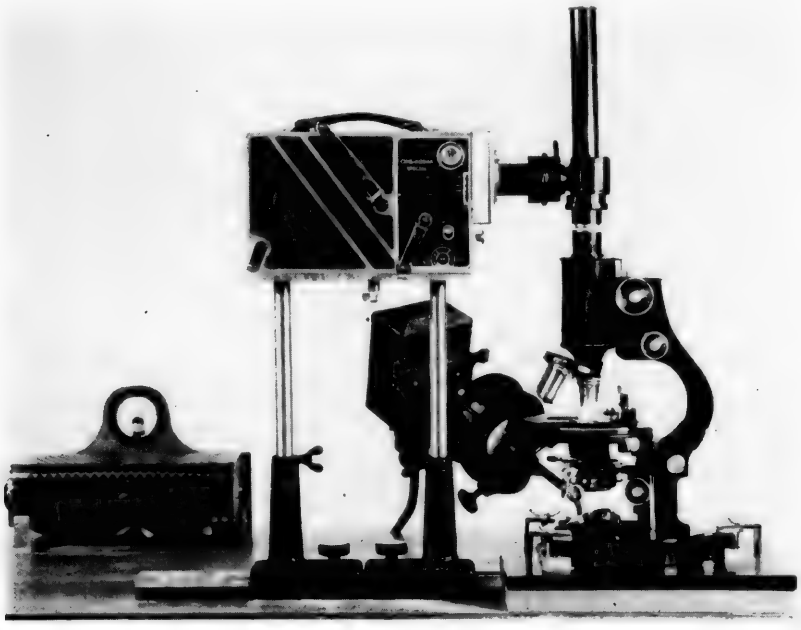

FIG. 2

the Kodachrome artificial light filter. Exposure was made at f:2.8. The lamp was two feet from the patient. The microscopic stained slides were exposed 16 frames a second for the high and dry magnifications, and 8 frames a second with the oil immersion. A 14-volt 56-watt lamp with a condenser was used for illumination. The Ciné-Kodak Special was used with a Bausch and Lomb microscope, beamsplitter and camera mount.

The clinical films were made with four Photoflood lamps in Kodaflec-

tors at f:1.9 and f:2.8. The artificial light filter was used and the lamps were three feet from the patients. The four lamps will illuminate about six square feet. When larger areas are illuminated, a proportionate

FIG. 3

number of lamps will be required. Pictures cannot be made in Kodachrome with regular operating room lights, as is possible with supersensitive panchromatic film. However, the regular operating lights can be used as auxiliary equipment.

It is almost impossible to give an accurate exposure guide for the number of lamps, their distance from the camera, and the proper diaphragm to use, because of the great number of variables in artificial lighting, all of which affect exposure. The distance of lamps from the subject and their angle in relation to the camera; the line voltage; the amount of blackening or other discoloration of bulbs; the type and efficiency of reflectors, and the shade of color of the subject, all have some effect on exposure. Therefore, before making serious pictures it is advisable to make an exposure test of a suitable test subject with new lamps, at a measured distance from the subject, and at a series of diaphragm openings. If an exposure meter is ordinarily used, it is advisable to make records of the readings made at the time of tests for future reference.

The filming of gross specimens, operations, clinical subjects and microscopic subjects in color is simple and practical.

The use of this new medium gives the medical profession a means not only of teaching by colored movies, but also of recording case histories for lecture purposes, personal library files, and for scientific study, never before possible on 16 mm. film.

At the present time, duplicate copies cannot be made, not because this is impossible, but because there hasn't been sufficient time to work out the technical details.

There is less eye strain from viewing Kodachrome than from any other motion pictures, including black and white. There is no mechanical registration to give blurred pictures; there are no lines or screen pattern on the film and no graininess. The lifelike naturalness of Kodachrome pictures makes one feel as if he were looking out through an open window at real life.

The art of making such pictures is still in its infancy. There are many improvements to be made and many technical refinements to be worked out before the perfection of Kodachrome in the 35 mm. field is attained.

COLOR CINEMATOGRAPHY IN SURGERY, ITS PRESENT AND FUTURE*

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A detailed description of cinematography in surgery has been given by the author in previously published articles. It is for this reason that black and white motion picture work will not be considered at this time. The previously published articles are: *The Dangers of Surgical Movies and How to Avoid Them*, New York Journal of Medicine, January 15, 1928, *Teaching Surgery with the Aid of Motion Pictures*, Medical Economics, February, 1933, *News Reel Hour of Medicine and Surgery*, Modern Medicine, February, 1936, and *The Cinema in Surgery*, Educational Screen, January, 1935. The last article in particular has created a good deal of interest as evidenced by the many inquiries relative to this subject and by the thousands of reprints distributed to the profession by a world wide cinematographic institution. The Peking and Tientsin Times of China, June 12–13, 1935, published the article, *The Cinema in Surgery*, practically verbatim in two consecutive issues of the paper. It was a report of the proceedings of a scientific meeting in Tientsin, China, where the value of motion pictures in surgery was discussed at great length. Reference to these articles may aid one interested in problems of cinematography and surgery.

A new problem has arisen which when properly solved will make motion pictures in general, and especially in the field of medicine and surgery, even more useful amd practical than ever before—that is, the production of these pictures in natural colors. The attraction of colored motion pictures, in general, is familiar to all of us. *La Cucarracha* and *Becky Sharp* presented in technicolor, caused much favorable comment as to the future of such films.

Now let us discuss some personal experiences with colored motion pictures in surgery. About four years ago the author was encouraged by the Eastman Kodak Company to take some surgical operations in color.

*Received for publication February 10, 1936.

This he did and the first of such colored motion pictures were a herniorraphy and open reduction of a fractured patella. These films photographically were satisfactory with some exceptions. It required a tremendous amount of lighting to obtain the desired results. This in itself was somewhat of a handicap to the surgeon and not so favorable to the tissues of the patient, though the operative end results in these cases were completely satisfactory. Then again in order to project the films on the screen a special auxiliary lens had to be used to obtain the color, which made it impractical to present black and white and colored scenes in the same reel. Then again it was not only impossible to make colored prints, but also the black and white prints were not feasible, for they had screen lines running through the film, making it distracting to the eye, and therefore not clear. This is explained by the fact that in order to obtain color in the film, the emulsion on each frame was arranged in prism-like fashion to give the fundamental colors. With these handicaps the writer did not deem it advisable to continue taking motion pictures in color until such time as these faults could be overcome.

After a lapse of three years, Kodachrome film was perfected which obviated most all of the previous difficulties. The author has used this film with great satisfaction for surgical motion pictures in color. Its principle is entirely different from the older film, Kodacolor. In the new film there are three layers of photographic emulsion, each sensitive to a different color, namely, red, blue and green, which are incorporated to give the desired elementary colors. Though, so far, colored prints are not readily available, it is expected that in the near future such prints will be easily procured. The black and white prints now made from the original colored films are perfectly clear, without screen lines, and are just as good, if not better, than the prints made from the original black and white film. Of particular value, also, is the fact that one does not need to change lenses as the same lens can be used for the showing of black and white and colored films. Thus far the author has had a number of his operative procedures, clinical findings and pathological specimens, gross and microscopic, taken in color with very gratifying results.

By means of a microscopic attachment to the motion picture camera, blood cells, bacteria and the tissue elements may be studied in actual colors. The natural hues of living tissue as well as the array of the many brilliant stains of the various fixed organisms and the dead tissues of

the body may be studied in color. The tubercle and diphtheria bacilli, the leucocytes, staphylococci and streptococci with the various background of colored tissues such as the yellow fat, the red muscle, the pink marrow, white nerves and walls of the blood vessels can all be seen as a riotously colored rainbow across the screen.

This constitutes a complete set-up for the student and teacher in the study of medicine and surgery. The clinical findings, physical examinations, blood counts, radiographs, surgical operations, pathology in vivo and dissection of the gross specimens, microscopic findings, the clinical course and end results, let us say, of a cancer of the stomach or intestine with resection, or a tumor of the kidney with nephrectomy—all presented in color and sound in composite form in the course of 20 minutes. Here is a presentation which otherwise would take hours to observe, and then only bit by bit at different times, at separate places, and in a scattered form.

It is now timely to discuss some essentials of obtaining satisfactory pictures in color. Artificial light, which is the medium of illuminating most operating rooms, has certain disadvantages which have to be overcome. It contains too much red which affects natural colors unfavorably when they are filmed. You may have noticed that when you enter a store to select a suit of clothes the salesman will place it under a lamp with a bluish hue so as to simulate daylight. He thus obviates the old custom of taking the suit to the window or door for inspection in natural daylight. So, too, artificial lights in the operating room may be corrected to simulate daylight by placing a glass filter with a bluish tint in front of the lens of the camera.

When feasible, sunlight should be utilized for colored pictures of surgical procedures. The colors then are most natural. Compare it if you will with any of the best artificial lights and the best selected filters. Of course, such lighting is not always available because the weather has no contractual obligations. It can, however, be used quite often for the presentation of specimens, clinical signs and symptoms and microscopic studies, most of which can be photographed at leisure during clear, sunny days. For operations, however, one must rely more often on artificial lighting.

Another drawback which should be overcome is the increased amount of lighting necessary in taking colored motion pictures as compared to the black and white. Roughly speaking, about three or four times the

amount of light is required. This is still somewhat of a handicap rather hard to overcome. The surgeon and the assistants may use dim glasses but the tissues of the body would still have to be protected from so much heat. This most likely will be overcome by the use of lights designed to radiate less heat. In the writer's experience there has not been so much difficulty, for he is accustomed to operating while the camera is at very close range, requiring relatively less lighting. Also, he uses the lights intermittently and only during the actual filming of the operation, which consumes just about ten minutes. This avoids any possible overheating and injury to the tissues.

To overcome any of these handicaps and also to secure the best natural colors, the writer has availed himself of the sun, whenever possible, in the following manner. He devised two circular mirrors, each about a foot in diameter. They can be supported by any well balanced stand and attached to such a stand by means of a double ball and socket joint in a manner similar to that of the ordinary head mirror, except that the ball of the mirror is fixed at the back in the center, instead of on the periphery, as in the head mirror. By using two such mirrors one can reflect the light from the sun at almost any angle to the field of operation.

A most practical application of these devices is to fix them to the same stands as hold the artificial lights in such a manner that they both can be used simultaneously or separately. In other words, when the sun disappears the artificial light is switched on, and when the sun shines again the artificial light is turned off and the reflected rays of the mirrors are utilized. This gives excellent light for natural colors without the disadvantage of excessive heat and crowding. When not in use the mirrors may easily be detached from their stands by merely loosening the joints. This arrangement can be used not only in the operating room but is applicable anywhere for photographing objects at considerable distance from the camera whenever the sun is available. Such mirrors may be also used to advantage in reflecting artificial light to obviate shadows and increase illumination.

What are the pros and cons of the black and white and colored motion pictures? Let me at the outset sound a jubilant note for those who have labored for years to record surgical procedures on ordinary black and white film. These motion picture records will continue to hold interest as they will always have certain advantages. Namely, there is always bound to be more clarity and detail because of the better depth of focus of the black and white. Also, one might concentrate much better on

the details of technique when there is no distraction of varied colors. However, one cannot deny that very natural colors with fine detail will impress the average student with greater force and probably leave a more lasting impression of the natural appearance of tissues.

Color film is particularly of value not so much in the showing of technique as in the presentation of pathological conditions of tissues and also of diseased conditions where color plays an important rôle. To show a degenerating fibroid of the uterus, a hypernephroma of the kidney, strangulated intestine or a cancer of the stomach, the rash of scarlet fever, measles or chicken pox, a diphtheritic patch, typhoid spots, or the cyanosis of pneumonia, the gangrene of a leg, erysipelas of the face, or disease of the skin in general, would be most effective when presented in color.

In addition to presentation of motion pictures in natural color, sound may play a very effective rôle in emphasizing some clinical phases of medicine and surgery. Take, for instance, a case of tuberculosis of the lungs. The flush and cyanosis with emaciation may be seen in natural colors, while the physical signs and symptoms as elicited by percussion and auscultation may be conveyed by means of sounds. The dullness, flatness, or tympany of the chest and abdomen may also be registered. By means of the stethoscope applied to the chest the sound may be transmitted to the recording apparatus to elicit the crepitant, sibilant and sonorous râles. Egophony, pleuritic friction rub, the cracked pot sounds of cavities, may all be recorded and presented in sound pictures. So, too, the rasping cough of bronchitis, the whoop in whooping cough, the grunt in pneumonia, the wheezing of the allergic and the asthmatic, the normal and abnormal breath and heart sounds, the pistol shot of aortic regurgitation, the systolic and diastolic pressure, can all be transmitted to the ears of the audience, the student and practitioner alike.

The cinema, as stated elsewhere, can not only record for permanent use the fundamental subjects of anatomy, physiology, pathology, clinical medicine and surgery, but also may leave for posterity the unusual and interesting cases which otherwise only very few would have occasion to see. It has been the writer's privilege to have developed a system of surgery in motion pictures embracing over 400 of his operations, including the clinical course, pathological findings and end results. In addition there are a great many reels dealing with physiology, surgical anatomy, and surgical pathology. In all, over 200 reels of 400 feet each.

The desire of man to leave behind him some work or achievement,

the ease with which medicine and surgery may be recorded for permanent use, their realistic impression on the minds of the student, especially when presented in natural colors,—urges one to give the cinema a permanent place in the teaching of medicine and surgery, as well as in a great many other fields of educational activity.

What an opportunity for educational philanthropy—to enable us to reap the benefits of a "visual foundation for medical education." No greater philanthropy could be bestowed upon humanity, as great as the Carnegie Foundation for Libraries, than to have a Ford, a Morgan, or a Rockefeller, endow a foundation for Visual Education. It would bear fruits as great as the library foundation of even a Carnegie, for the efficiency of visual education by the cinema, even exceeds that of mere words or even still pictures.

The Romance of Surgery, its past history and present accomplishments, may in a large measure be portrayed in a visual form with the aid of the cinema.

It may sound futuristic to make the following statements but, nevertheless, they may become a reality: It will be considered unfair to subject the students of the future to the trying task of visualizing and memorizing facts by the study of text books, when such subjects may be more readily mastered by the aid of the cinema. The cinema lightens the burden of the student and teacher. The perfection of the motion pictures in natural colors, with sound, adds another argument in favor of its adoption for popular use in teaching, for mastering the fundamentals, for reviewing the old and keeping abreast of the new.

The present and the future of civilization will in a large measure be profoundly influenced by this record of science—the cinema. Will Hays, the czar of the motion picture industry, stated in a radio broadcast, that in the future many text books will be printed on celluloid instead of paper. The cinema in all its phases challenges every industry and every institution of learning, to utilize it in its various forms, not merely as a novelty, but as an essential aid in education as well as in entertainment.

BIOLOGICAL ILLUSTRATIONS AND THE PHOTO-ENGRAVER*†

E. G. KARTH

Chicago, Ill.

There is a very distinct relationship between the medical illustrator and the engraver and publisher. The one is dependent upon the other for good results, and it is with the aim of obtaining these good results or even better results that I shall endeavor to explain to you in my own way just what happens to your illustrations when put through an engraving plant.

Every industry has its history and so too the photo-engraving industry, and inasmuch as we know it to be a fact and all agreed upon the historical background, I shall dispense with any further remarks as to how many years ago it started and why.

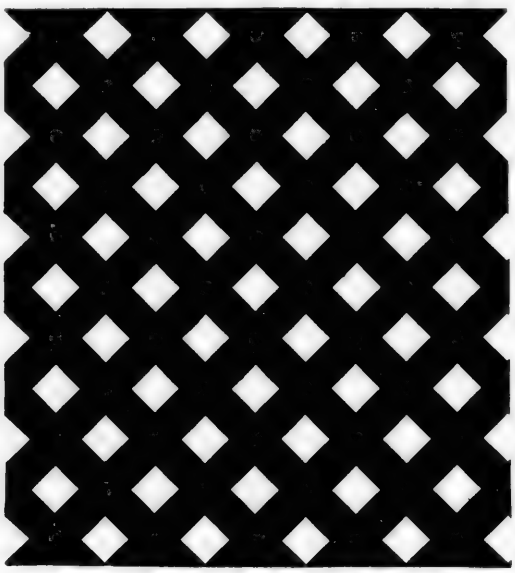
The process of photo-engraving is essentially chemical; based on the actinic property of light—sunlight—to cause definite change in certain metallic salts in contact with organic matter. This actinic property is demonstrated by changing color of ripening fruit and by the autumnal coloring of most foliage. In practice, of course, sunlight is too unreliable, although it is used under certain favorable conditions and where long exposures are practical. The apparatus used is comparatively simple, yet continual operation is essential for dependable service.

A bellows camera on a sliding base mounted on a rigid frame work, resting on springs to compensate vibration is used. A copy board stands vertically at one end of the frame. The lens mounted in one end of the box is usually of anastigmat type to give fine definition clear to the edge of the plate. This, by the way, explains why the proportion of a copy is not distorted and why it cannot be changed in the camera. But the size of the copy can be enlarged or reduced within a wide range. The back of the camera carries a ground glass on which the image of the copy can be focused to a specified size. I say "a" because only one dimension should be specified—the other will be in true proportion. A halftone screen is set into position immediately in front of the ground glass. The screen is composed of two pieces of very fine glass,

*From the Jahn and Ollier Engraving Company.

†Read at the 1935 Convention of the Biological Photographic Association.

each having opaque parallel lines diagonally over one face, the ruled faces being cemented together. Looking through the screen you see a miniature window screen turned at an angle of 45 degrees—in fact, a coarse screen halftone could be made with a common window screen. These screen lines divide the area into thousands of minute lenses. For instance, there are 17,689 clear spaces in a square inch of the most commonly used 133 line screen. The fineness or coarseness of the screen



The above illustration shows a greatly enlarged section of a screen. The black lines are the same width as the transparent lines, thus the ratio is 50-50. When the screen is placed on the camera between the original picture and the photographic negative the black lines intercept the light and break up the image into squares or dots. Thus, we get the "halftone" negative.

is determined by the surface of the paper to be used in printing. For instance, newspapers which are generally printed on very crude and coarse paper take a 55, a 65 and up to an 85 line screen. Magazines and trade papers take up to 120 screen, while the finer grade of printing requires from a 133 to a 150 and sometimes a 166 or a 175 line screen. The general commercial halftone screen is composed of 133 lines to the square inch. The general magazine screen is of 120 lines.

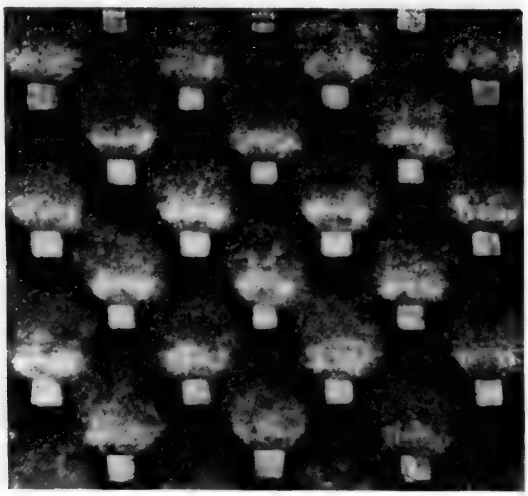
A halftone illustration may be produced from various kinds of copy, such as photographs, wash drawings or paintings in any medium, or it may be made from a fabric, lace or even small objects themselves.

At each side of the camera are arc lights of strong actinic value to illuminate the copy. When focused sharply to size, the ground glass is replaced by the plate holder into which a sensitized plate has been placed. The plates used are generally coated by the operator with collodion, and known as "wet plates." The collodion consists of gun cotton dissolved in alcohol and ether, and is flowed on a clear albumen-coated glass plate. The plate is sensitized by submerging in a silver nitrate bath. While still wet the plate is exposed to the reflected image of the copy coming through the lens. The white light of the white background changes the nature of the silver salts—rendering them insoluble. The black lines and tones of the copy absorb the light, thus the exact image of the drawing or copy is photographed. In making the exposure through a halftone screen, timing and distance between the screen and plate are matters requiring great skill, experience and judgment. In short, a negative is a series of dots in various sizes and shapes with due allowance for etching. After a carefully timed exposure, the plate is skillfully developed and intensified or reduced, producing a negative or image of the copy in reverse position and color.

Unlike the portrait photographer's dry plates, wet plate negatives cannot be retouched, which is another reason necessitating good copy.

Next, the negative is coated with a rubber solution, and again with collodion. The negative, now a thin film, is loosened from the original glass by soaking in water and turned over onto another glass plate. It is "flopped" as we say, to be later reversed in the final printing. At this stage the film may be cut, rearranged or combined with other negatives for various reasons: for instance, a border design or line may be wanted around a halftone illustration; or two negatives may be made of an intricate half border to be joined in stripping. Furthermore, a halftone negative may be laid over a line negative, or perhaps on only a portion of it, to produce a gray tone by cutting the line image with white lines or dots. This *stripping* is a valuable means of helping artists and advertisers. The negative is naturally adhesive and any joining or patch line may be retouched. The negative is now ready for printing on metal. Copper of select quality is cleaned and polished. Next the metal is coated with a solution of albumen, LePage's Glue and am-

monium bichromate and whirled over a hot gas plate to dry. The negative and now light sensitive metal are placed in contact in a printing frame just as one handles an ordinary film and printing paper. The arc light quickly affects the coating through the clear transparent lines and dots of the negative and renders it insoluble. The opaque areas shield the coating and leave it unaffected. After removing from the printing frame, the metal is carefully washed under a tap to dissolve and wash off the unaffected solution.



This photomicrograph shows a plan view of the dot formation on the halftone plate. It can be seen that the dots are not exact squares as the screen construction would indicate; because the thickness of the glass screen keeps the black line slightly out of contact with the negative and permits the infinitesimal light rays to filter under the microscopic edges of the black lines.

The metal is then dried and put into a hot oven to bake the remaining solution. This baking or "carbonization" forms the acid resisting surface which protects the metal during the etching process.

An enamel print is virtually a photographic print of dark brownish color baked on a copper background. The first or flat etching is done with perchloride of iron to a depth of about two one-thousandths of an inch. The plate is now carefully studied and compared with the copy. Areas which are sufficiently etched for color are painted or crayoned

over with an acid resistant and areas requiring further etching are treated with handbrushing. This process of staging and etching is known as re-etching. After the plate has been re-etched, it is chalked up with magnesia powder and is again carefully checked with the original drawing to see that the reproduction is faithful. From the etchers the plate goes to the routers operating a milling machine on a movable arm.

Any outlining which may be necessary is done with a hand graver to give the machine operator a guide for his cutting bit.

The operator skillfully guides the cutting bit around the outline of the image into all of the spaces $\frac{1}{4}''$ or larger in area, and the metal is chipped out to a depth so that it will not print when put on the press. After this operation it is necessary to tack the plate on a good block of well seasoned wood and plane it down to accurate type height and remove any burrs and roughness. Any spots or whites to be re-engraved are now cut out of the surface. We are now ready to print directly from this plate or to duplicate it by electrotyping or stereotyping.

Line etchings are produced in much the same fashion with the exception of removal of the halftone screen. Generally they are etched on zinc and a solution of nitric acid is used to do the etching.

To protect the sides of the lines during the etching process, an acid resisting powder is brushed against the lines and baked to form a good resistant.

After a series of four powderings and etchings the metal has been sufficiently etched down to obtain a good printing depth. The plate is then put through the routing, finishing and printing departments in much the same fashion as the halftone plate.

So much for the production of a line and halftone photo-engraving. I wish to go into the preparation of copy as I might be able to find one or two things which would be of interest. I presume that the greater percentage of copy supplied by you to your publisher or engraver is photographic print material. Quite naturally you are interested in obtaining the best quality of print to send for reproduction, but the natural question is "what is the best quality of print?" Every specimen you photograph and every illustration you make is photographed or made for a very specific purpose; therefore, I would say the print that shows or tells the story most clearly and effectively is the print you want to use and the best for photo-engraving reproduction.

After all, the photograph is a story and if your picture does not tell the story clearly, the reader will not understand it. There are a few things involved in photographic prints cropping up from a chemical standpoint which have a tendency to give the photo-engraver quite a bit of trouble. One of these is the green tone print, caused by under-exposure, over-developing or lack of washing.

Being interested in the photographic field, you, of course, know that green has a photographic reaction to a sensitized plate. Consequently, when the whites in a photographic print have been toned green, their photographic reproduction is not that of a pure white tone as it should be. The separation of details in the shadows is seriously affected by the green tint, making it practically impossible to get detail in the shadows. The particular point is, *do not* send out green prints for reproduction. The same is true, of course, of prints on ivory paper or India paper or any color tinted print. After all, when you send your copy to the engraver, you are generally asking him to turn out a black and white job, so why not give him black and white copy instead of a tinted or colored copy.

There are a few questions relative to the photographic print which you may have in mind and I am going to try to answer them in a fashion which I hope will satisfy.

The first question is: "Must prints be made on glossy paper?" The answer is: "*Yes.*" The reason being that in photographing prints for reproduction in photo-engraving, we photograph the *reflected* light. The glossy prints are reflective, much more so than matte surface prints or any other finished print, consequently the glossy print is the best to use. This statement does not mean that we cannot reproduce from matte prints or other finished prints, but it means that glossy prints make the best reproductions.

The second question: "To what extent does the color of the print matter?" The answer is, "To a very great extent." I am assuming by color of the print you mean the tone of the print. Normally photographic prints are black and white. The paper is pure white, having been correctly developed and washed. Sometimes the prints come through the photographic department not thoroughly washed or perhaps over-developed and with a greenish tone. Prints of this color are very troublesome inasmuch as green photographs much stronger than white; consequently, the contrast is reduced. The great trouble comes

in the shadows in which the detail is irretrievably lost. Van Dyke or brown prints on white paper or strong blue prints on white paper or any other colored prints on white paper, present the same difficulties in the shadows.

The next question: "What about bluish and brownish prints on the same mount?" When blue and brown prints are mounted together on the same copy, they require separate exposures. This, of course, presents difficulty, which ordinarily is not very serious because the job can be stripped together; but it makes extra expense which perhaps can be eliminated in the original makeup of the copy.

"What about reproduction of colored drawings?" I assume that these colored drawings are to contain all the primary colors and black. A drawing for black and white reproduction must be color corrected with a general color corrected negative. In color correcting a colored drawing with a general color correction negative, we find that the yellow photographs lightest, red next, blue next and black is the fourth tonal value. In other words, we get a general relationship in the black and white photograph such as is normally contained in the colored illustration. Of course, it is possible to use various color filters to intensify any one of the colors.

"Is it important to make prints of a size so that they will reduce in reproduction?" The answer is: "*Yes*, because it sharpens the detail, up to a certain reduction." To explain this a bit more fully, let us assume you have a photograph with very small details. Should this photograph be of a size which would require a reduction to one-third or one-fourth or a greater reduction, you can readily see that the small details would soon be lost in the screen which is necessarily used in making the engraving. Therefore, a photograph of such detail should not be reduced so much. Perfect prints will reproduce satisfactorily even on enlargement.

DISCUSSION OF MR. KARTH'S PAPER

MR. SCHMIDT: I know that photo-engravers prefer to reduce their copy, but in the Rockefeller Institute for Medical Research, 90 per cent of our pictures for illustration are made up natural size. When a doctor comes in for a photomicrograph, he wants the picture at a certain magnification, and we make it for him at that magnification. If we enlarge the negative, and then have it reduced, the final picture may not be of the same quality. If there are three or four pictures on one page, it is sometimes quite an effort to reduce them all to specified magnifications. I am speaking mostly of photomicrography. Often, if you make a picture larger than specification for a doctor, and then he sees it reduced in a journal, he is disappointed by the final picture.

MR. KARTH: The doctor's disappointment introduces a personal element, but the fact remains that a picture given the benefit of reduction is sharpened. It is especially essential to reduce drawings made by hand. No matter how good the hand work, it can be improved by reduction.

MR. SCHMIDT: I agree that in drawings, reduction is advisable. However, even in drawing, perfectly good copy can be made natural size. When it comes to photomicrography, it is not optically quite the same thing to enlarge a picture to 200 diameters and then have it reduced to 100, as to take the picture at 100 diameters originally.

MR. ZIELER: If it is intended to use a photomicrograph for reproduction in publications by the halftone method, the question of magnification and rendition of detail is of great importance. We have been told that the screens generally used for making halftones have approximately 133 dots per inch. It is quite evident that if we do not wish to lose detail in reproducing a photomicrograph we have to see to it that in this photomicrograph the finest detail is not separated farther than 1/133 of an inch. Objective, eye-piece and bellows expansion of the camera determine the magnification, but it is only the numerical aperture of the objective which determines the *resolving power* of the microscope. That means that only through the selection of the objective can we control the

degree of sharpness of the photomicrograph. The value of the numerical aperture is always engraved on the mount of the objective, or it can be learned from the catalogues of the manufacturers. Without going into mathematical detail about the formula for the resolving power of the microscope, the biological photographer can guide himself by the rough rule that in general the total magnification of the photograph should not be more than 600 to 800 times the value of the numerical aperture. For instance, if a 16 mm. objective of the achromatic type is used, its numerical aperture is 0.25 and by multiplying this by 800 we arrive at the fact that this objective should never be used for photomicrographs of magnifications higher than 200×. It is also true that when the iris diaphragm of the condenser is closed considerably, the resolving power decreases. In such cases one should not use more than 400 to 600 times the value of the numerical aperture.

If, of course, the photomicrograph submitted by the photographer to the photo-engraver is reduced when the halftone is made, the original magnification can be higher. Let us assume, for instance, that in making the halftone, the photomicrograph is reduced in the ratio of 2 to 1. In this case the original magnification of the photomicrograph, made with a numerical aperture of 0.25, could have been not 200× but 400×, because after reduction the magnification is still 200 diameters, or 800 times the value of the numerical aperture. The detail is not farther apart than the screen of the halftone.

MR. CREER: As to the matter of contrast, in prints to be reproduced, do contrast prints look better in halftone than the softer print?

MR. KARTH: That depends on how essential the tones of your picture are. If the picture is largely a matter of contour, contrast is all right, but if you need detail in the shadows and high lights, softer prints are better.

MR. CREER: I recently visited Mr. Charles Thomas of the Charles Thomas Publishing Company, and showed him several pictures, each printed in two grades of contrast. I asked him to choose the one that would reproduce better. He picked out the contrast print in each case.

MR. KARTH: He probably took the contrast print because detail in the shadows and high lights was not important, and the contrast prints had better blacks, on which he could get a finer pin-point dot. Only a jet black gives a real black in a halftone reproduction.

MR. CREER: Would you go on record as saying that for the general run of pictures you would recommend a slightly contrast print?

MR. KARTH: Since you say *slightly*—yes.

MR. JONES: I wonder if there is not some way we can develop collaboration between author, illustrator, and photo-engraver. The engraver would appreciate this collaboration, and often the artist or photographer, working directly with him, accomplishes amazing results.

MR. SCHMIDT: This collaboration obtains to a high degree in the institution in which I work. I control the decision in regard to proof and am in direct contact with the engraver. The same firm has handled our engraving for 25 years, and their work has been most satisfactory. If those who prepare a large amount of proof would make it their aim to give suggestions and criticisms, and at all times to make it quite clear what effect they want, the effort would be much appreciated.

MR. CLARKE: We should all visit photo-engraving establishments. The engravers are extremely cooperative, especially about a job in hand. They have a publication "The Art of Photo-Engraving" which is very helpful. It tells you, for instance, what not to do in preparing prints for publication, and gives many helpful pointers to photographers who have seen little of their work reproduced.

MR. SCHMIDT: We may as well make up our minds that we cannot get an absolute copy in a halftone. For instance, we always get a gray instead of a pure white unless the finisher goes through a mechanical process which is expensive.

DR. PROETZ: Unfortunately for the photographer, there are two middle men between him and the engraver, namely the author of the article, and the editor of the journal. The author is ordinarily an

amateur writer, turning out an article every year or two, and cannot remember technical requirements between papers. Even if the original illustration is excellent, he may mount six or eight prints on one sheet of paper, in such a way that they cannot possibly be mounted on the page; or he may try to write with ink on glossy prints; or he will outline an x-ray shadow with ink, and obscure just the line one wants to see.

The editor is also, in many instances, an amateur. The great majority of medical editors are men in the private practice of medicine. Unless he has given particular attention to the matter, he is not able to correct the author's mistakes, or give him much advice.

If a manual of practice could be published by this Society, it would be a great help, both to authors and to editors.

MR. SCHMIDT: The Wistar Institute publishes such a book which is a complete treatise on the subject. The Rockefeller Institute for Medical Research has also issued a booklet on the preparation of manuscript and illustrations for publication. I, also, have written on this subject for our Journal and will send a reprint to any one upon written request. I agree with you that an article on this subject should reach such editors and authors as you mention.

PHOTOMICROGRAPHS FOR COLOR REPRODUCTION*†

ROY M. REEVE

Washington, D. C.

The purpose of this article is to outline briefly the methods used at the Army Medical Museum in making photomicrographs for publication in color with a few added suggestions which may be of assistance to others confronted with the prospect of performing work of this character. The preparation of photomicrographs for color reproduction need not offer any great difficulty to the photographer who has the proper equipment and is willing to give the task the necessary time and study.

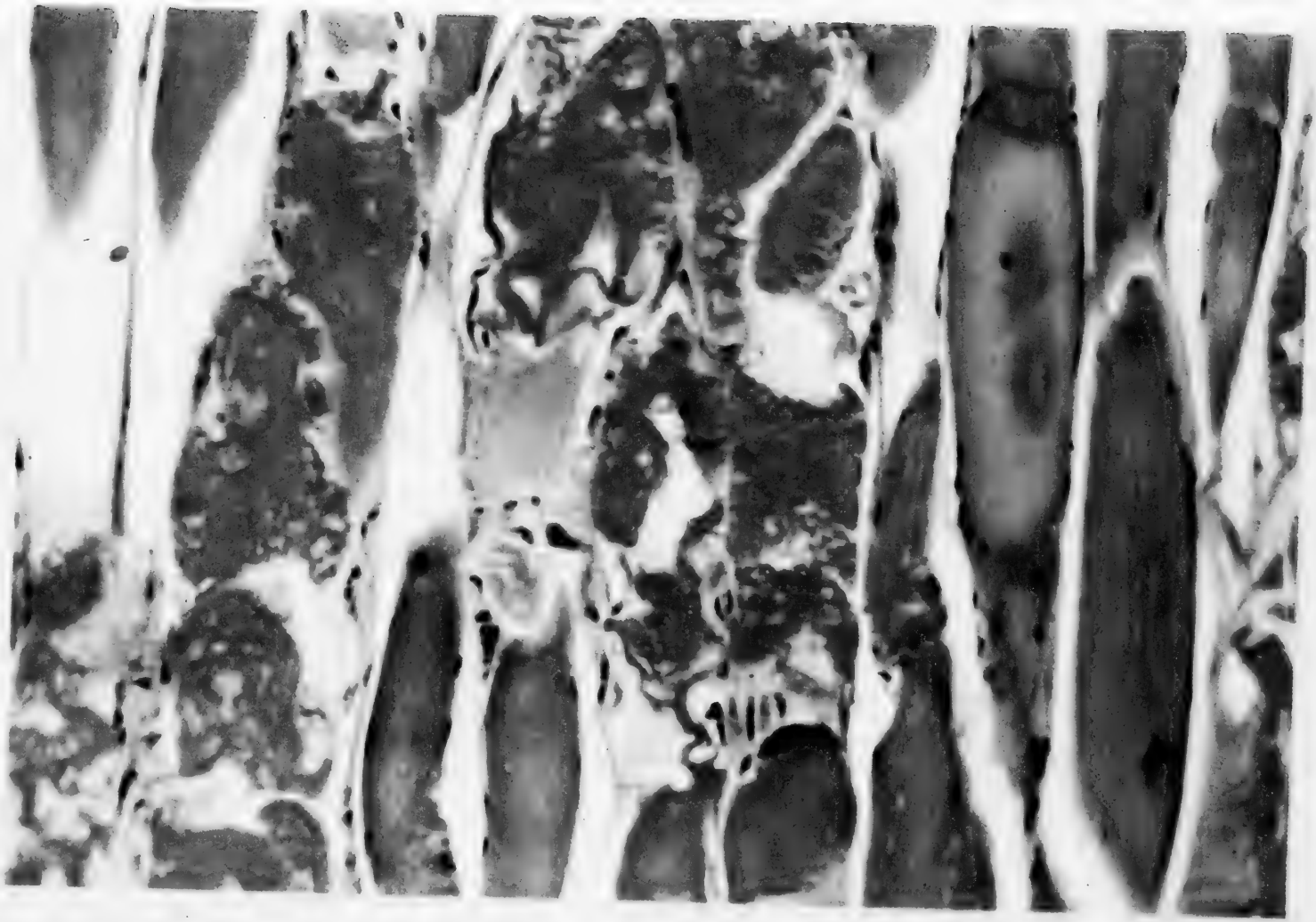
There are two recognized methods commonly used for this purpose. The first is the preparation of three color separation negatives by the use of standard tri-color filters. This is commonly known as the subtrac-

* From the Army Medical Museum.

† Received for publication September 30, 1935.

tive method. Three color separation negatives are not always successful unless the photo-engraver is furnished with some kind of color guide to aid him in obtaining the proper shades of color. The second method is the use of the screen plate in which all of the color filters are incorporated in a single screen placed under the sensitive emulsion or held in contact with it while the exposure is being made. This is known as the additive method. The screen plate method produces all of the colors on a single transparency but is objectionable in that the grounds are not clean and the color values are not recorded as well as in a good set of separation negatives. The photo-engraver would also have to make a set of separation negatives from the screen plate which might not be as good as an original set of negatives. The most satisfactory method is the combination of three color separation negatives for the use of the photo-engraver in making his cuts and a screen plate to serve as a color guide. The greatest accuracy and detail can be obtained by making a fourth color separation negative through a K-3 filter from which the engraver makes a faint gray print for detail values in the grays and blacks.

At the Army Medical Museum a standard photomicrographic apparatus is used. This is equipped with a ribbon filament type of light. The correct centering of the light on the substage condenser through the objective to the ground glass is more important in color work than in making monochrome negatives. Apochromatic objectives are used as it is essential that all the spectral colors focus in the same plane to obtain three images of exactly the same size. The field to be photographed is selected, carefully focused and all movable parts locked in position to prevent movement of the field or the camera. Three separate negatives are made on panchromatic plates each being exposed through one of the standard tri-color filters. Plates are essential as films may shrink to different sizes in drying. Any change in the size of one of the images spoils the entire set. The filter factors furnished with the plates are used as a guide in determining the amount of exposure. The three negatives are marked for future identification and for the engraver's information: "'A' filter or blue printer," "'B' filter or red printer" and "'C' filter or yellow printer." It is desirable for the photo-engraver to have some definite marks for exact registration of the three images. This is accomplished by securely fastening very fine wires across the ends and sides of the camera back near the plate holder about one-quarter of an inch inside



the field of vision. Being near the sensitive photographic plate they form very sharp and distinct lines along the sides and ends of the negative which serve as guides for the engraver and are near enough to the edge of the print to be trimmed after registration is complete. The plates are developed in a metol-hydrochinon developer. Negatives for this purpose should be full of detail and not too contrasty. When the set of separation negatives is developed and found to be satisfactory a screen plate transparency is made of the same field as nearly accurate in color values as possible. This is made without any filter. It is developed and reversed to a positive in accordance with the instructions furnished by the manufacturer of the particular type of plate used. The set of separation negatives and the screen plate are then ready for the photo-engraver.

The color illustrations in Volume XII, *Pathology of The Acute Respiratory Disease, Gas Gangrene Following War Wounds, The Medical Department of the U. S. Army in the World War 1929*, were made by the methods described. The accompanying plate is taken from this book.

It is not necessary that the ribbon filament type of light be employed. Other methods of lighting may be satisfactory when the proper filter factors are used. Micro tessars are satisfactory for low power work but apochromatic lenses are essential for the higher magnifications. Sometimes lenses marked "apochromatic" are not fully corrected. A simple test for correction is to focus with the "A" or red filter and without changing the microscopic adjustment replace the "A" filter with the "C" or blue filter. If this causes a change in the focus the lens is not satisfactory for making color separation negatives. The filters are placed between the light and the substage condenser. Filters mounted in glass by the manufacturer or the plain gelatine filters are satisfactory.

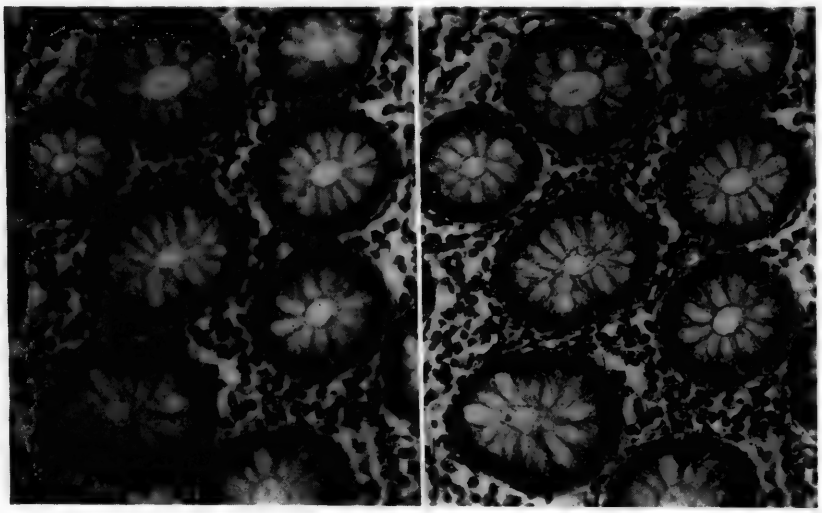
A recent improvement in the method outlined above is the development of a printing process for three color separation negatives by which a true color print, instead of the screen plate, can be furnished the photo-engraver.

PRINT CRITICISM

LEONARD A. JULIN

Rochester, Minn.

The criticism print published in this issue demonstrates an effect obtained by several of our readers who have complained about hazy appearing photomicrographs. They had carefully placed the camera, microscope and illuminant in alignment and had cleaned the lens surfaces. Color filters were used to increase contrast but the results were not satisfactory due to glare produced by using the substage condenser iris at too large an aperture. In making these photographs the following technic was used. The lamp was equipped with a lens and iris diaphragm and the image of the ribbon filament was focused on the iris diaphragm of the substage condenser. The specimen was placed on the microscope and focused. The lamp iris was reduced to a small opening and brought into focus on the same plane as the subject by means of the rack movement of the substage condenser. The lamp diaphragm was opened just sufficiently to clear the edge of the field seen in the microscope. Figure A was then made using the technic indicated under the illustration. The substage iris



A B

SECTION OF DUODENUM. × 300

Apo. 8 mm. objective and × 10 Comp. eyepiece

Fig. A. ½ second exposure using full condenser cone

Fig. B. 4 seconds exposure using two-thirds condenser cone

Negatives made on D. C. Ortho plates using Wratten filters B and G together.

diaphragm was stopped down until approximately a two-thirds condenser cone was reached. Figure B was then made using the technic indicated.

If the camera is moved away from the microscope and a pin-hole eye-piece is used one can readily observe the back surface of the objective. With the substage condenser iris wide open and with a medium power objective the back lens of the latter will be seen to be filled with light. The diaphragm aperture is then reduced until this lens is approximately four-fifths filled with light. This is commonly considered the largest opening that it is advisable to use for histological work. Usually, however, a somewhat smaller aperture will give more desirable results. The amount of reduction to use varies with the specimen and is usually determined by observing the effect on the ground glass of the camera. This can be watched as the aperture is reduced until the desired effect is attained. Too small an opening will give poor results so one should use as large a condenser cone as possible while still obtaining the desired effect.

The correct use of the substage condenser and its iris diaphragm is a subject that may profitably be studied by anyone interested in the production of better photomicrographs.

PHOTOGRAPHIC TECHNIC, NEW PROCESSES AND EQUIPMENT*

F. R. HARDING

Boston, Mass.

ADDITIONAL NOTES ON RADIOGRAPHIC REPRODUCTION

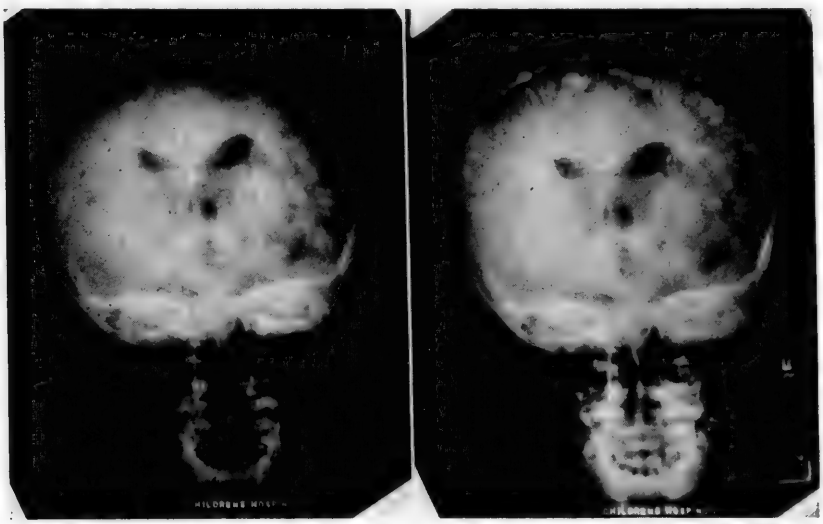
Certain dense areas in radiographic films have always been very troublesome to reproduce. Notably the upper margin of anterior-posterior and posterior-anterior skull plates, laterals of spines which show a severe kyphos, and chest plates in which there is a large variation of density in the left and right lungs. Several methods have been devised to make possible a more even distribution of light which would allow more detail to register in the dense portions of the reproduction.

The following method appears to produce such a result without unduly increasing the time devoted to making these reproductions:

The film is set up in the usual manner, and the initial exposure is made. The source of illumination is then turned off and a previously prepared "local" lamp is employed. This is a 100 watt lamp, placed in a wire guard such as is employed with trouble lights or garage extension cords. The guard is covered with any fire resisting, opaque material, leaving

* From the Department of Photography, Children's Hospital.

the outer end open. This lamp is turned on and held close to the back of the glass "sandwich" which contains radiographic film.[1] The lamp must be kept in motion while locally exposing the dense areas, and care must be taken that it does not lap over into areas of normal density. When a large curved area, such as a skull outline is being treated, the lamp is made to pass back and forth over the dense area. If the area to be locally exposed is too small to fit the circle of light, a mask, the opening of which is slightly smaller than the area to be exposed, may be fastened to the open end of the lamp. Some experimenting will be necessary to determine the additional exposure required by the local illumination.



A B

"A" is made in the usual manner. "B" is made with the addition of a local light. Both reproductions are from the same radiographic film.

The writer has recently employed this method, and so far has had excellent results.

USES FOR THE EXTENSION BED AND SLIDING TRIPOD BLOCK

Many view and clinical cameras are equipped with an extension bed, and a few, the Eastman view and the Korona view for examples, are also equipped with a

[1] Harding, F. R.: *Method for Making X-ray Prints for Reproduction.* Jour. Biol. Photo. Assn., Vol. 1, No. 3, March, 1933.

sliding tripod block, which will be found under the main bed rails of the camera. This sliding tripod block greatly increases the usefulness of the camera to the clinical photographer. Small specimens may be placed on a suitable background on the floor. By utilizing a tripod with a tilting head and placing the extension bed in its proper position on the camera, these specimens may be photographed greater than life size without difficulty. This is usually impossible without placing the specimens on a pedestal, because the tripod will not lower sufficiently to allow focusing to be done.

Lower the tripod, usually of the "home portrait" type, as far as possible, then tilt the tripod head and camera at a right angle, toward the floor. Loosen the locking thumb screw which holds the sliding tripod block in place. Slide the camera and bed down the tripod block to the proper point and lock the bed in place with the locking thumb screw of the tripod block.

The bed and block may also be employed on patients when close up views are desired and it is not practical to place the tripod very close to the subject. Simply slide the camera and bed through the block toward the subject. Employing a 5″ x 7″ Eastman view camera, it is possible to gain about twelve inches in this manner.

TEMPORARY REPAIR OF ENAMELED TRAYS

Frequently an enameled tray becomes chipped, and in time the underlying steel rusts through. This often occurs at a most inopportune time. A rapid temporary repair may be effected by reaming out the loose rust around the hole. Twist a small pledget of cotton which will fit the hole and impregnate it with hot paraffin. Draw the cotton through the hole in the tray, and while the paraffin is still semi-liquid, mold the cotton into a small button on both the inner and outer surfaces of the tray. Allow the cotton and paraffin to set and then pour water into the tray. If any leak is present, empty the tray and heat the repair on both sides. Remold the button and again test for leaks. This method works perfectly so long as no warm or hot liquids are placed in the tray. The writer repaired a developing tray in this manner and used it daily for five years. Several times it developed a slow leak. Reheating and molding always closed the leak. Asphaltum may also be used instead of paraffin. It is stronger and more heat resisting and is thoroughly acid and alkali proof.

A Chicago newspaper has been a pioneer in a remarkable photographic development which has made possible what are styled "Candid Movie Stills." Using a Bell & Howell hand-held 35 mm. Eyemo motion picture camera equipped with a special shutter, this newspaper has been able to give its readers a sensational succession of vivid, attention-arresting sets of news pictures, each set, or series, showing continuous action photos of the event depicted.

It takes a movie camera to make pictures in this rapid succession. For continuous candid work the Eyemo movie camera, which weighs only seven pounds, is usually fitted with an 18-degree shutter that reduces the exposure time to 1/324th second when the camera is operated at 16 frames per second. At 32 speed the exposure time is only 1/648th second, short enough to "stop" even the fastest action. Smaller shutters are available to double this speed, if desired. The use of either of these shutters makes the pictures so sharp that they can be enlarged without loss of distinctness.

After the pictures are taken, the photographer selects the individual shots that tell the complete story.

It is possible that a camera of this type would be an excellent auxiliary piece of equipment for the clinical photographer.

A new Bell & Howell Film Splicer for 16 mm. silent, 16 mm. sound, and 8 mm. film makes available to the amateur the same quick, easy, precise splicing procedure that is offered by the B & H Standard Laboratory Splicers, after which this new substandard model is patterned.

As with the Laboratory Splicer, each film end is located on pilot pins once only. After each film end has been placed between its pair of clamp plates, the emulsion is removed from the left film end with a dry scraper. Then cement is applied, and the right clamp plates are immediately lowered, shearing both film ends and bringing the bonding areas together in a single operation. A lock maintains the pressure until the splice has set—a matter of seconds.

The new splicer, known as Model 136, makes the exclusive B & H diagonal splice. Its pilot pins engage perforations on one side of the film only, so that 16 mm. sound film and 8 mm. film are handled as easily as 16 mm. silent film.

Model 136 has a cast metal base designed to take, as Add-a-Unit equipment features, a B & H Direct Viewer, or a two-way Rewinder, or both, in the same way as the previous amateur splicer. The Direct Viewer, equipped with a light, lens, and ground glass translucent screen, magnifies the film images for the operator's convenience in finding cutting places. Rewinder units are available in either 400- or 1600-foot reel capacity.

B & H Safety Film Cement for Splicer 136 is supplied in a new, improved bottle. The small neck of this bottle reduces evaporation. The brush is attached to a screw cap which gives positive sealing.

THE NEW ORTHO-STEREO CAMERA AND ORTHO-STEREOSCOPE

Hitherto, the complicated procedure required for accurate stereoscopic work at magnifications greater than unity, and especially with small objects, has discouraged many who have felt the desirability and need for records showing proper perspective, true relief, and freedom from all distortion.

With this coordinated combination of camera and viewer, it becomes a simple routine matter to make and view such photographic records with all the impression of solidity possessed by the objects themselves. In effect the photographic presentation is equivalent to viewing a scaled model with the unaided eye at normal viewing distance, under the condition that the model scale equals the magnification employed.

In the study of medicine, stereoscopic records have unlimited possibilities. They assist students to visualize complex structures, pathological growths and lesions and to retain realistic impressions of dissections. Research centers can keep permanent stereoscopic records of important work accomplished for reference interchange.

Museums, too, will find constant and profitable use for the Ortho-Stereo Camera in photographing rare and valuable objects, such as crystals, jewels, archaeological specimens and mounted objects.

The Ortho-Stereoscope magnifies the stereogram 2.1×. Thus the ultimate magnification of the object when viewed with it will be equal to the product of the magnification due to the camera alone and the magnification due to the stereoscope.

The lens combinations provided are used to secure ultimate magnifications when viewed in the Ortho-Stereoscope, as shown in the table below:

Photographic magnification	*Ultimate magnification when viewed*
0.48×	1.0×
0.83×	1.7×
1.83×	3.75×
3.24×	6.6×
5.37×	11.0×
11.75×	24.0×

The Bausch & Lomb Ortho-Stereo equipment is so designed that all of the above conditions are automatically and precisely met without computation and with practically no manipulation on the part of the operator. Furthermore, the severest handicap of manipulation in the making of stereo photographs, namely the need for transposition of prints in mounting, has been eliminated completely. In the Bausch & Lomb equipment, both pictures of the pair, each 70 mm. square, are automatically transposed during photography and are recorded on a single 5″ x 7″ plate at the proper separation and orientation. The operator has only to use a single piece of printing paper, develop and mount it without cutting or transposing views. This unique feature reduces the technic of making the photographs to no more work than that involved in making single or non-stereo photographs.

The Ortho-Stereo Camera is of the fixed focus type with fine adjustment and may be used in either vertical or horizontal position. It is fitted with a double slide carrying a frame into which may be placed either the ground glass focusing screen, or the standard 5″ x 7″ plate holder. Just below this slide, a cylindrical drum may be revolved to various stops, each stop corresponding to the ultimate magnification for which the camera is set, and which limits plate shift to the exact distance required for the magnification. The manipulation of this slide also causes the automatic transposition of the views between the exposures.

At the bottom of the camera chamber is mounted a photographic shutter, which may be adjusted for time, release, and instantaneous exposures of varying durations. Attached to this shutter is a dovetail clamp into which the objectives are introduced and locked. Each objective is attached to an appropriate adapter, which has a slot of exactly the correct length to permit only the lateral motion required.

The Ortho-Stereoscope is designed for viewing prints made with the Ortho-Stereo Camera. It consists of a stereoscope, with adjustment for interpupillary distance, supported on a metal stand for convenience in use.

A UNIVERSAL DEVELOPER

No. 779

Contributed by M. G. SCHNECKENBURGER

359 Sycamore Street, East Aurora, N. Y.

The following developer has been used by the writer, in museum and commercial work for the last 12 years. It has been found good for almost any kind of tray development that is required, such as for films, prints, and lantern slides. Credit for this formula should be given to Mr. James Johnson of Buffalo, N. Y., a prominent architect whose hobbies included photography and chemistry. This was his experiment No. 779. The carbonate and sulphite can be varied to meet different conditions or needs. It does not stain the fingers.

1. Mix exactly as follows:

Boiling water	About 12 oz.
Hydroquinone	1 oz.
Metol	1 oz.
Pyro	1 oz.

Add one at a time in the order given to the boiling water and continue to boil at least one minute.

2

Cold or cool water	About 15 oz.
Sodium Bisulphite	1 oz.
Potassium Bromide	¼ oz.

For a stock solution add No. 1 to No. 2 and enough water to make 1 quart.

For use:

Water	1 qt.
Carbonate of Soda	2 oz.
Sulphite of Soda	1½ oz.
Stock Solution No. 779	1 oz.

Association News

The Sixth Annual Meeting of the Biological Photographic Association will be held in Boston, Mass., about September 17th.

* * * *

An enthusiastic group of Bostonian photographers convened at the Children's Hospital, Boston, on February 7th and organized the Boston Chapter of the Biological Photographic Association. A constitution was adopted and the following officers were elected.

Chairman.....Mr. F. R. Harding
Secry.-Treas.....Mr. Lawrence Brown

Plans for the 1936 B. P. A. Convention, which is to be held in Boston, were discussed. At this first meeting, Mr. Harding gave a demonstration and talk on the photography of gross pathological specimens. He described in particular, illumination of the subject and background. He also exhibited about forty Agfa color slides of dermatological conditions.

The Boston Chapter at this writing is growing rapidly and there is every indication that this group will become a very lusty offspring.

* * * *

The Awards allowed for prints hung at the last meeting are now in the mails.

* * * *

The Second Traveling Salon will be exhibited in the Department of Biology, Wesleyan University, Middletown, Conn., through the courtesy of Dr. H. B. Goodrich. Its next destination is Mount Holyoke College, South Hadley, Mass., where it will be hung under the sponsorship of Dr. A. H. Morgan.

* * * *

Dr. C. G. Eddy formerly of the Photographic Department, Mayo Clinic, has been appointed to the position of photographer to the Eloise (Michigan) Hospital and Infirmary.

* * * *

Mr. John M. Muir formerly of Oak Terrace, Minn., is now associated with Mr. Jean Kieffer at the Norwich State Tuberculosis Sanatorium, in Connecticut.

* * * *

The following letter was received from the editor of *Modern Medicine*, 84 South Tenth St., Minneapolis, Minn. No doubt some of our members will be interested in supplying the requested material.

"Dear Sir:

Everybody says that 'pictures tell the story.' In the matter of medical pictures, however, it has been my experience that far too few tell a story that is new to the doctor.

"We are always interested in seeing (and buying, when they fit our needs) a photograph or series of photographs which tell a story of something new in medicine. As far as clinical photographs go, before and after pictures are about the best thing that we have found yet. These illustrate the result of a certain therapy and are often effective to this end. However, there are only a limited number of conditions probably, in which this type of photograph would have a real news value.

"If photographers kept in close touch with clinical and experimental research men so that these photographs might be used to illustrate clinically significant facts just as soon as these facts were ascertained, the news value of the photographs taken at that time would considerably enhance their intrinsic interest.

"We shall be glad to have submitted to us the photographs which will interest the rank and file of medical men and will also be glad to receive any suggestions on this topic. To anyone desiring it, we will be glad to send a sample copy of our publication, Modern Medicine.

Very truly yours,
Modern Medicine
Justus J. Schifferes, M.A.
Managing Editor"

* * * *

The meeting of the New York Chapter of the Biological Photographic Association was held November 19 in the New York Academy of Medicine, where the photographic display of the Association was exhibited. The exhibit was of great interest and showed many developments which should encourage all biological photographers to greater endeavors.

The meeting was devoted to a symposium on the subject of infra-red photography. Mr. Wolfgang Ziehler opened the evening with a brief talk on the characteristics of infra-red radiation, the reason for their greater power of penetration and an explanation of many of the characteristic reactions of this radiation. Mr. Louis Schmidt then presented several lantern slides of infra-red work done at the Rockefeller Institute together with several transparencies prepared by Miss Greenberg. Most of these presented the same subject made on ortho and on infra-red plates to show the contrast. Mr. Schmidt was followed by Mr. Carlisle of the Rockefeller Institute of Princeton, New Jersey. Mr. Carlisle exhibited some slides showing how, in botanical work where the usual contrast filters used with panchromatic materials give very unsatisfactory results, the infra-red gives the investigator records of great clarity and usefulness.

The consensus was that the biological value of infra-red photography lay principally in the photography of subcutaneous phenomena, and that additional knowledge would be required before it becomes a fully recognized member of the biologically useful photographic emulsions. Mr. L. Paul Flory of the Boyce Thompson Institute did not agree with this attitude. In closing the symposium, Mr. Flory presented a great

many technical points together with formulae and statistical data gathered from laboratories in this country and abroad showing that a very great deal has been done in tabulating exact data in the infra-red. Mr. Flory is of the opinion that inasmuch as the infra-red is a region of radiation rather than a single specific wavelength, that we may expect varied phenomena when using it, depending upon the wavelength employed, the specific reactions of the object or substance photographed to that specific wavelength and in the use of filters which have definitely restricted infra-red transmissions. He believes the use of filters which freely pass all infra-red to be as thoroughly unsatisfactory as using panchromatic emulsions with no filter for photography in the visual region. The facts presented were given very careful consideration as Mr. Flory has been using infra-red in his own research for the past five years.

* * * *

An article in the November 1935, *Turtox News*, *The Possibilities of Polarized Light for the Biology Teacher* is of current value due to the large amount of interest recently shown in the use of polarized light in photography.

* * * *

The American Photographic Publishing Co., 428 Newbury St., Boston, Mass., has just published their latest catalogue called *Books on Photography*. It is probably the most complete list of such books available. In nearly all cases a brief description of the book is included. A copy may be had on request.

* * * *

Mr. S. C. Dunton, Photographer at the New York Aquarium and former Treasurer of the Biological Photographic Association, has produced a two-reel motion picture entitled *Trailing the Seahorse*. The film is on 35 mm. stock and is scored for sound. The dialogue was revised by Mr. C. W. Coates of the New York Aquarium staff and the narration is by Johnny Martin of WOR.

The picture was recently previewed at the Annual Meeting of the New York Zoological Society at the Waldorf-Astoria Hotel in New York City, and was very favorably received by an audience of some 1,800 people.

Mr. Dunton expects to release the film both on 35 mm. and 16 mm. stock, both versions being with sound. The picture deals with seahorses, how they are kept at the Aquarium and the manner in which they are collected. Both tank shots and actual underwater photography are featured in the picture.

* * * *

We wish to welcome the following new members to our Association:

Allen, Muriel L., 159 Hudson Avenue, Albany, New York.
Allen, William Maynard, 605 Fowler Avenue, Durham, N. C.
Anthony, A. W., Jr., 31 Horne Road, Belmont, Mass.
Archer, Dr. W. Harry, 908 May Building, Pittsburgh, Pa.
Baker, Clinton L., Memphis, Tenn.
Brown, Dr. Chester R., 555 West 227th St., New York City.
Bunton, Paul B., 602 Transportation Bldg., Spencer Lens Company, Washington, D. C.

Carr, Dr. Gladys L., Meadowbrook Hospital, Hempstead, L. I., N. Y.
Chester, D. W., 47 Winter Street, Waterville, Maine.
Claff, C. Lloyd, 5 Van Beal Road, Randolph, Mass.
Conzett, Miss Luella, 771 Mahoning Avenue, N.W., Warren, Ohio.
Dillman, Dr. Melvin A., Jefferson Medical College, Dept. of Roentgenology, Philadelphia, Pa.
Foust, H. L., Iowa State College, Ames, Iowa.
Franke, Dr. Kurt W., South Dakota State College of Agriculture & Mechanical Arts, Brookings, South Dakota.
Futterman, Dr. Max J., 2021 Grand Concourse, New York City.
Gould, Dr. S. E., Eloise Hospital & Infirmary, Eloise, Michigan.
Graybeal, W. Harold, University of Maryland, Lombard & Greene Streets, Baltimore, Maryland.
Grille, George A., Jr., 1704—37th St., N.W., Washington, D. C.
Guernsey, Mrs. J. B., 208 Scott Street, Council Bluffs, Iowa.
Heimiller, Cameron James, 4436 Wrenwood Avenue, Baltimore, Maryland.
Hetler, Dr. Donald M., Washington University School of Medicine, St. Louis, Missouri.
Hollander, Miss Audrey, New York Hospital & Cornell Medical College, New York City.
Kent, F. W., Physics Building, Iowa City, Iowa.
Kocksis, Paul, 74 Van Cortlandt Park, South, Bronx, New York City.
Koplik, Dr. Lewis Henry, 311 E. 72nd Street, New York City.
Leon, Maxwell J., 121 Amboy Street, Brooklyn, New York.
Misumi, Ichiro, 429 Spruce Street, San Francisco, Calif.
Mueller, Carl W., Easton Hospital, Easton, Pennsylvania.
Mulgannon, F. P., E. Leitz, Inc., 1427 "I" Street, N.W., Washington, D. C.
Oppenheimer, Dr. Jane, Osborn Zoological Laboratory, Yale University, New Haven, Connecticut.
Proetz, Dr. Arthur W., 1010 Beaumont Bldg., St. Louis, Missouri.
Ritter, Jack, 1919 Madison Avenue, New York City.
Ryan, George F., 418 S. Lang Avenue, Pittsburgh, Pa.
Thompson, E. Ward, 29 Charles Street, Quincy, Mass.
Walcott, A. G., Norfolk, Conn.
Wantz, C. H., 2012 W. Jackson Blvd., Chicago, Illinois.
Waters, L. A., Chamber of Commerce Bldg., Syracuse, New York.

SURVEY OF EDUCATIONAL FILMS

A survey to list all motion pictures which have an educational value is being conducted jointly by the U. S. Office of Education and the American Council on Education in Washington. This includes not only the strict classroom film, but subjects useful to medical students, scientific workers, vocational classes, C.C.C. camps, teachers and other specialized educational groups. The survey is being made under a grant from the General Education Board (Rockefeller) and is part of the work being carried on

by the American Council on Education in connection with its sponsorship of the proposed American Educational Film Institute.

More than 10,000 film catalog cards have been mailed to 1800 sources of films in this country. This card covers nearly 100 items which will result in accurate information being filed in one central office covering information necessary to judge the adaptability of the film to specific educational needs. Supplemental analyses and listings will be prepared and publicized in an appropriate manner.

Both agencies cooperating in this survey desire that this central information file be made as complete as possible. Any person or organization that has produced, now owns or has the exclusive distribution rights to any motion picture that should be included in this list, and who has not received the film catalog cards sent out under this survey, will be sent a supply of the cards upon writing to the American Council on Education at 744 Jackson Place, Washington, D. C.

INFORMATION FOR COMPLETING FILM CATALOG CARDS

1. *Listing of all films.* In order to make a thorough survey of the educational film resources of this country it will be necessary to list all kinds of films.
   This includes:
   Films showing countries, customs, professions or how the people of the world live. This also includes current events, reproductions of literature and other instructional topics.
   Advertising films showing industrial processes, business operations, natural resources, movements of raw stocks, and similar subjects.
   Scientific, medical, technical films showing research, experiments, operations. medical practice, therapeutics or similar topics.
   All other films suitable for teaching purposes.
   When films are in long and short versions, separate cards and separate detailed synopses should be filled in.
2. *Separate cards.* A listing on a separate card is desired for each motion picture suitable for educational purposes. Each film will be classified according to its different uses. For example, the information about medical films will be reserved for circulation among those groups actually interested in such films. Subjects showing school activities and teaching methods will find their field of circulation among teacher groups. Many industrial films may find increased use in C.C.C. camps and other vocational classes. Supplemental analyses and listings of films suitable for special groups will be prepared and publicized in an appropriate manner.
3. *A complete description.* A teacher cannot tell from a title alone, or from a brief line or two of description, whether a film is suitable for a specific purpose. Many films are useful in more than one type of class. For example, a travel picture may be of value for geography, industry, vocations, customs, sports, history, architecture, transportation and other topics. A detailed synopsis is necessary in order to list properly the film under each of the subjects to which it is applicable. A paragraph of at least 100 words will be most useful.

4. *All items are needed.* Each item requested is necessary in order to give the agencies making this survey an accurate idea of the exact nature and possibility of each film listed. The technical information will enable educational groups to judge whether certain films should be brought before them for preview and further analysis. The information regarding the present location and condition of the negative and prints will enable schools and other groups to locate films of value in an expanding program of visual instruction.

Your cooperation in making this listing as complete as possible will be appreciated by the agencies making this survey.

Motion Picture Committee,
DR. OSCAR RICHARDS, *Chairman.*

Journal of the
Biological Photographic Association

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Entered as second class matter March 15, 1932, at the Post Office at Baltimore, Maryland, under the Act of March 3, 1879.
Made in the United States of America

VOLUME IV *June, 1936* NUMBER 4

The Journal of the
Biological Photographic
Association

FILTERS FOR THE SEPARATION OF LIVING AND DEAD LEAVES IN MONOCHROMATIC PHOTOGRAPHS WITH A METHOD FOR THE DETERMINATION OF PHOTOGRAPHIC FILTER FACTORS*†

G. R. VAN ATTA

Berkeley, California

The Division of Plant Disease Control of the Bureau of Entomology and Plant Quarantine frequently has occasion to photograph white pines which bear limbs killed by white pine blister rust, the purpose of such photography being to show the extent of injury to the tree. Examination of customary methods of photography did not reveal any suitable means of sharply differentiating between the green of the uninfected limbs and the reddish-brown color of the limbs and needles killed by the rust. The same inadequacy of photographic technic has been apparent in pictures designed to show the toxic effects of chemicals on Ribes. The study described in this report was undertaken to determine a practical method of securing such color differentiation.

Ordinary monochromatic photographs made without filters usually show the greens and browns of living and dead plant foliage as indistinguishable shades of the same color. This is true because the photographic brightnesses of the objects are nearly the same. Even though it may be possible to distinguish in the photograph between living and

*From the Division of Plant Disease Control, Bureau of Entomology and Plant Quarantine, U. S. Department of Agriculture.

†Received for publication January 15, 1936.

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dead leaves when the entire field is evenly illuminated at the time the picture is taken, this distinction is not possible when high lights and shadows exist. If greens and browns are to be rendered in monochrome so that living leaves can be readily distinguished from dead foliage, it will be necessary to find some means whereby their differences in brightness can be greatly exaggerated. It should be possible to achieve the desired result by employing light of only those wave lengths which are highly reflected by one of the materials concerned and very little by the others.

Before this work was undertaken it was known that under certain circumstances red filters such as Wratten # 25 or "A" had been successfully used to differentiate photographically between living and dead foliage. When this filter is used the major part of the light active in forming the photographic image of a leaf is that reflected by the red, orange, or yellow leaf pigments, and, since these are present in somewhat comparable quantities in both living and dead leaves, the resulting negative often shows only a short scale of variation in gray. It was thought that better color separation might be obtained through the use of filters whose transmission of visible light was limited to deep red. The following sections outline the work that was done with red filters.

APPARATUS AND MATERIALS

All exposures were made with a $2\frac{1}{4}''$ by $3\frac{1}{4}''$ Graflex Camera equipped with an f: 4.5 Bausch and Lomb Tessar lens. Eastman Supersensitive Panchromatic cut film was used throughout the experiments.

Three filters were used. One was a gelatine filter, Wratten # 25 or "A" filter, cemented between B glass. The other two filters were polished glass plates made by the Jena Glass Works of Jena, Germany and listed in the manufacturer's catalog # 4892E as RG1 and RG5. These plates were approximately 50 mm. square and 2 mm. thick.*

A Weston Photronic Cell Model 594 and a Type NX Westinghouse DC microammeter rating 0–50 microamperes were used to measure the light for all exposures. The cell was equipped with a 30° angle of inci-

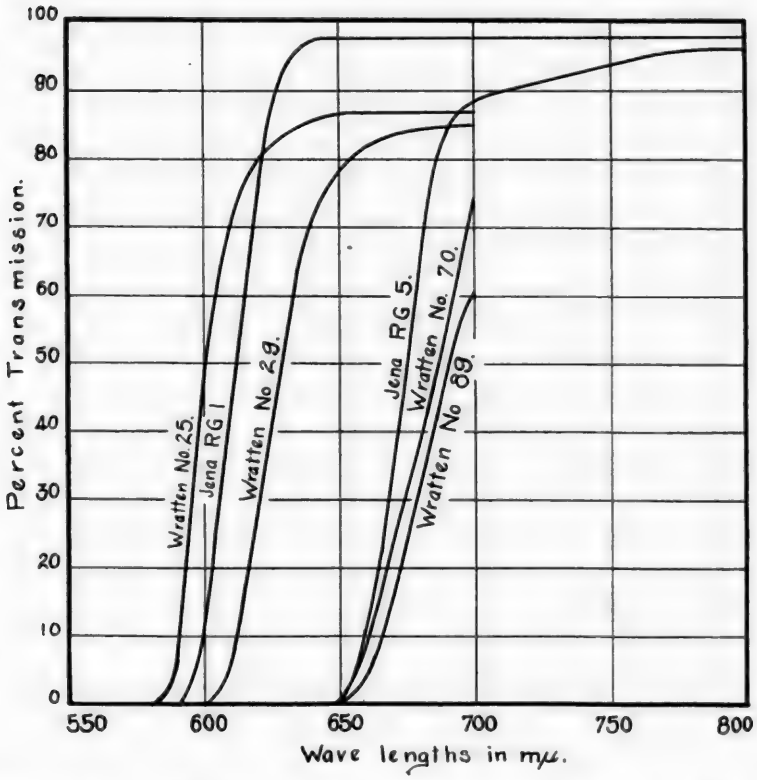
* The Wratten filters are sold by the Eastman Kodak Company, Rochester, N. Y. The Jena filters used in this work were purchased from the United States agents for the manufacturers, Fish-Shurman Corp., 230 East 45th Street, New York, N. Y. The Jena filters can be obtained in plates of almost any size and thickness. The plates described above were purchased for $3.50 each

dence grid. The instrument assembly had been calibrated against a Weston Universal Exposure Meter, Model 617, Type 2, so that it was possible to convert directly microamperes of current to foot candles.

A pocket watch was used to time most of the longer exposures. Time

Figure No. 1.

Percent Transmission of Several Red Filters.



exposures involving fractions of seconds were timed with the aid of a metronome.

All films were developed with Eastman D76 fine grain developer solution and fixed in acid hypo.

All contact prints were made on Azo F No. 2, glossy, single weight, paper. Eastman D72 developing solution was used to develop all prints.

Percentage transmission curves for the filters used in this work are shown in figure 1. The corresponding curves for three other red gelatine filters are also shown in the figure. The data from which the transmission curves for Wratten filters were drawn, were taken from "Wratten Light Filters" (1). The Jena filters were made from calibrated glasses and the transmission curves were drawn from the calibration data furnished by the manufacturers.

The subjects chosen for all the trial photographs were living and dead pine trees and needles. The choice of subject was limited to this type of plant by the season of the year and the region in which the work was performed. Photographs were taken of a number of species of pines. The prints contained in this report were, however, from photographs of specimens of *Pinus pinea* growing on the Berkeley Campus of the University of California. The live needles of this tree are rather dark green in color. Most of the dead needles were dark and dull in appearance from exposure to city smoke and dust.

DETERMINATION OF FILTER FACTORS

It is unnecessary to determine the correct filter factors to apply when using some of the commoner Wratten filters (e.g. ✱25 and ✱29) with Eastman Supersensitive Panchromatic cut film since the manufacturer supplies these data with each package of film purchased. Various methods are in use for calculating filter factors. Perhaps the most generally accepted method is the one reported by Davis and Neeland (2), which is based upon the well-known earlier work of Hurter and Driffield.

Lacking the somewhat elaborate and costly apparatus required for the determination of filter factors by the usual methods, it was necessary to find some other means of securing these data for some of the filters to be tested in this work.

Through the courtesy of Mr. Walter Clark of the Eastman Kodak Company, Research Laboratories in Rochester, New York, the writer was supplied with a copy of the spectral sensitivity curves to the equal energy spectrum, of a particular batch of Eastman Supersensitive Panchromatic film. From this curve a table was prepared which expressed the relative sensitivity of the film to the equal energy spectrum at a

number of wave lengths upon the basis of an arbitrary numerical standard.

The composition of the light used has an important bearing upon the result of photographic exposure and it is necessary to take this fact into account when calculating exposures. Since the equal energy spectrum is not used in making ordinary photographic exposures, light of that composition is not a proper basis for the determination of filter factors. For the purpose of calculating exposures that are to be made in the day time out-of-doors, the standard illumination generally chosen is a light having approximately the composition of mean noon sunlight. In order to use this standard of illumination in the present work, it was

Figure No. 2.

Apparent Relative Sensitivity of Supersensitive Panchromatic Film to Mean Noon Sunlight

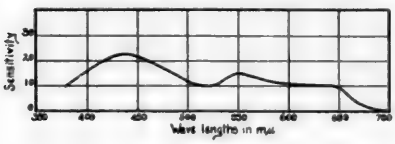


Figure No. 3

Apparent Relative Sensitivity of Supersensitive Panchromatic Film to Fraction of Mean Noon Sunlight Transmitted by Wratten Filter No. 25

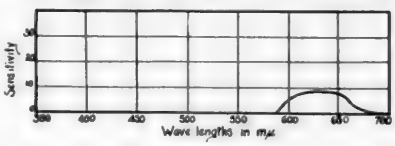


Figure No. 4

Apparent Relative Sensitivity of Supersensitive Panchromatic Film to Fraction of Mean Noon Sunlight Transmitted by Jena Filter RG 1

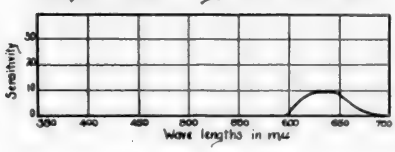
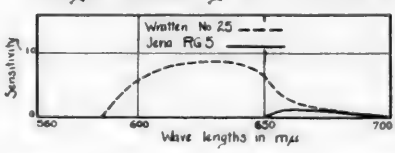


Figure No. 5.

Apparent Relative Sensitivity of Supersensitive Panchromatic Film to Fraction of Mean Noon Sunlight Transmitted by Jena Filter RG 5



necessary to convert the relative sensitivity of the film to the equal energy spectrum to its apparent relative sensitivity to mean noon sunlight. Accordingly, a table which gave the relative spectral energy distribution of mean noon sunlight at a number of wave lengths was prepared from data furnished by the Weston Electrical Instrument Company (3). A third table which gave the apparent relative spectral sensitivity of the film to mean noon sunlight was then prepared by multiplying the relative sensitivity of the film to the equal energy spectrum at a number of wave lengths by the corresponding relative spectral energies of mean noon sunlight. The curve shown in figure 2 was drawn from these data.

The glasses of which camera lenses are composed are not transparent

to light of all wave lengths. Although their transmission cut-off is not perfectly sharp at 400 mμ for practical purposes no serious error is introduced in the final result if camera lenses are considered as being opaque to light of wave lengths shorter than 400 mμ and uniformly transparent to the remainder of the visible spectrum. This means that the relative sensitivity curve in figure 2 may be considered to end at 400 mμ so far as photographic exposure is concerned.

After the curve in figure 2 had been drawn, the next step was to prepare a table giving the apparent relative sensitivity of the same film to that fraction of mean noon sunlight transmitted by a Wratten #25 or "A" filter. This was done by multiplying the apparent relative sensitivity of the bare film to mean noon sun at a number of wave lengths by the corresponding filter transmission values. A graph was drawn from these figures to the same scale as that used in drawing figure 2. This curve is reproduced in figure 3.

It is apparent that the ratio of the response of the bare film to mean noon sun to its response to light from the same source transmitted by an "A" filter will be proportional to the area under the curve in figure 2 between 400 mμ and 700 mμ divided by the area under the curve in figure 3. When the respective areas were measured with a planimeter it was found that the ratio was six to one. That is, the area under the curve representing the response of the bare film to mean noon sun between 400 mμ and 700 mμ was six times as great as the area under the curve representing the response of the film to the light from the same source transmitted by the "A" filter. This means that the "A" filter factor for the particular batch of film to which the equal energy spectral sensitivity data applied was six. It was necessary to determine this value in order to identify qualitatively the batch of film from which the basic data were derived for reasons that will be made apparent later.

The exposure factors for the Jena filters RG1 and RG5 were determined in a manner exactly analogous to the method used in determining the factor for the Wratten "A" filter. The film response curves corresponding to filters RG1 and RG5, each approximately corrected for reflection losses, are shown in figures 4 and 5 respectively. The latter curve is reproduced in somewhat larger scale than the others. To assist in making comparison, the curve in figure 3 is repeated in figure 5. The areas under the various curves and the calculated filter factors are given in table 1.

The exposure factors shown in this table are correct for the particular batch of film from which the basic sensitivity data were taken. Different lots of the same kind of film do not, however, always have exactly the same sensitivity. These variations unavoidably arise in the processes of manufacture. Emulsion sensitivity may also vary under the influence of other factors such as the age of the film, but trouble from these sources may largely be avoided by not using a film after its expiration date.

The filter factors furnished with each package of Eastman Supersensitive Panchromatic cut film furnish an index of the spectral sensitivity of the film. Thus, the exposure factor given for the "A" filter is indicative of the sensitivity of the film to red light. This fact makes it possible to calculate the correct exposure factors for any particular batch of

TABLE 1

Apparent relative response of supersensitive panchromatic film to mean noon sun

FILTER	AREA UNDER CURVE	EXPOSURE FACTOR
Lens system only	330.00	1.0
Wratten #25	55.00	6.0
Jena RG1	47.90	6.9
Jena RG5	2.87	115.0

Eastman Supersensitive Panchromatic cut film from the data that has been given here and the "A" filter factor furnished with the film. The way in which this may be done is as follows:

Suppose one wishes to calculate the RG5 filter factor for a film the "A" factor for which is 5. From the data given in table 1, it is seen that when the "A" factor is 6 the RG5 factor is 115, or, stated another way, the RG5 factor is 19.2 times the "A" factor. The RG5 factor sought can now be found by multiplying 5 (the new "A" factor) by 19.2. The product is 96 or roughly 100.

In the following text, the number 19.2 will be referred to as the "A" Factor Ratio for the RG5 filter. Similarly, the number obtained by dividing the RG1 factor by the "A" factor, both as given in table 1, will be called the "A" Factor Ratio for the RG1 filter. The correct value of the RG1 "A" Factor Ratio is 6.9 divided by 6, or 1.15.

TEXT EXPOSURES

The correctness of the "A" Factor Ratios calculated for the two Jena filters was thoroughly tested in a large number of trials. In each series of these trials a subject under constant conditions of illumination was photographed once without a filter and several times with the aid of the filter being tested. The lens opening used for all exposures in a series was the same but the exposures were of various lengths of time.

Numerous trial negatives were also made to compare the degree of color separation attainable with the Wratten "A" filter and each of the

TABLE 2

Exposure data for light filter tests

FILM NUMBER	DATE	TIME	AVERAGE BRIGHTNESS OF SUBJECT*	DISTANCE CAMERA TO PRINCIPAL SUBJECT	FILTER	FACTOR (ACTUAL)†	EXPOSURE		"A" FACTOR RATIO (ACTUAL)
							Aperture *f* system	Time	
			footcandles	*feet*				*seconds*	
10-1	3/27/35	12 a.m.	80	2	None	1.0	5.6	1/80	
10-2	3/27/35	12 a.m.	80	2	"A"	6.4	5.6	10/125	
10-3	3/27/35	12 a.m.	80	2	RG1	8.0	5.6	1/10	1.3
10-4	3/27/35	12 a.m.	80	2	RG5	240.0	5.6	3	40.0
11-1	4/10/35	3 p.m.	80	3	None	1.0	5.6	1/80	
11-2	4/10/35	3 p.m.	80	3	"A"	5.3	5.6	1/15	1.06
11-3	4/10/35	3 p.m.	80	3	RG5	100.0	5.6	1–1/4	25.0
11-6	4/10/35	3 p.m.	80	3	RG5	240.0	5.6	3	58.0

* All these exposures were made of subjects in direct sunlight.

† Manufacturer's "A" factor for films 10-1 to 10-4 was 6.

Manufacturer's "A" factor for films 11-1, 2, 3 and 6 was 5.

two Jena filters. In these tests, as in the others, one negative of each subject was made without a filter. The regular procedure followed was to set the camera on a tripod, bring the subject into focus without a filter, measure the average intensity of the light coming from the subject, and then make the exposures with the various filters one after another without changing the focus adjustment. The subjects were all considered as having "normal" contrast for the purpose of calculating exposures and the film was rated at a speed of 24 on the Weston scale.

It is not practical to include in this report prints from all the trial negatives, and a limited selection has been made which it is hoped will

illustrate the basis for most of the conclusions reached. The exposure data for the photographs shown are given in table 2.

DISCUSSION OF RESULTS

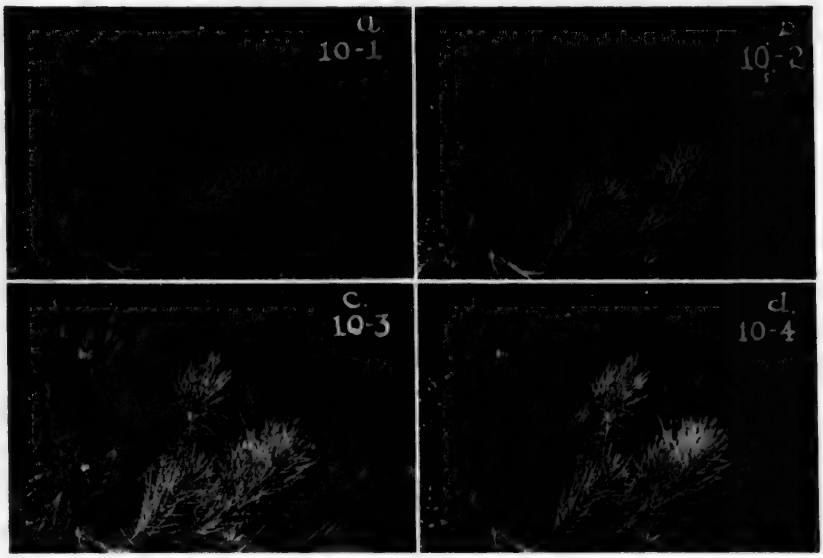
Although most of the remarks that follow refer specifically to the photographs shown here, they apply equally to the results of all the tests made under like conditions.

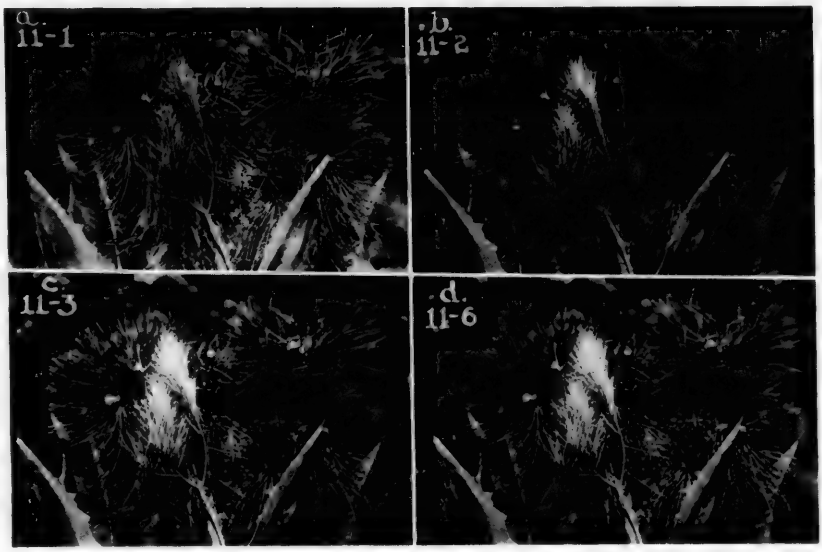
Prints 10-1 and 11-1 show the color blindness that is to be expected when negatives of this type of subject are made without a filter. Contrast between greens and browns appears to some extent in prints 10-2 and 11-2, but it is not enough to differentiate unmistakably between living and dead foliage. Under the most favorable light conditions the Wratten "A" filter is capable of producing better contrast than is shown in these prints, but ideal lighting is infrequently encountered in practice and for this reason the "A" filter cannot always be depended upon to furnish satisfactory results.

Print 10-3 shows that the Jena RG1 filter does not produce sensibly better results than the "A" filter. This indicates that if a red filter is to be found which will afford a high degree of contrast in these subjects, it will be one the transmission of which will begin at considerably longer wave lengths than 600 milli microns.

Prints 10-4, 11-3 and 6 show that good contrast can be obtained with a Jena RG5 filter under the same light conditions that prevailed when the corresponding exposures were made through the "A" filter. The same change in lighting that produced better contrast in print 11-2 than in print 10-2 also produced a like improvement of contrast in prints 11-3 and 6 over that shown in 10-4. This difference in the degree of contrast attainable with the two filters was typical of the results of all the tests.

The data in table 2 show that prints 10-4 and 11-6 were made from negatives that had been subjected to considerably longer exposures than were necessary upon the basis of the calculated "A" Factor Ratio for the RG5 filter. Notwithstanding this fact, the prints do not show evidence of over-exposure by a marked lessening of contrast. Indeed, it would be very difficult to distinguish print 11-6 from print 11-3 were it not for the identifying film numbers. This point is reassuring because it indicates that the scale of contrast obtained with this filter can be correctly rendered in the film even though the exposure is two and one-





half times its minimum correct duration. The density of the RG5 filter is so great that visual focusing with the filter in place is quite impossible and for this reason it is interesting to observe that in these tests it was

not necessary to adjust the focus specially for the RG5 filter. It would have been bothersome but not very difficult to determine focus corrections to be applied if it had been necessary to do so. It is improbable that use of this filter will ever require special focusing since most of the modern lenses are highly achromatized.

Due to their long exposures, negatives 10-4 and 11-6 were of slightly more than average density. All trial exposures made through the RG5 filter with an "A" Factor Ratio at or very near the theoretical value of 19.2, such as number 11-3, gave negatives of the same density as were produced when an "A" filter was used with the factor recommended by the film manufacturer. In all the last-named instances, the negatives were light and fast printing, but not at all lacking in detail. They were easy to print by contact and admirably suited for projection printing.

Attention is now called to the following facts: The degree of photographic contrast between greens and browns increases with the wave length of the light employed in making the exposure. The further the filter transmission threshold is moved toward the red end of the spectrum, the greater will be the contrast obtained. This expedient is limited, however, by the spectral sensitivity of the emulsion used. The sensitivity of Eastman Supersensitive Panchromatic film ends at approximately 700 milli microns. If this material is to be used, it is necessary that the transmission of the filters employed begin at wave lengths shorter than 700 milli microns. It is evident that as the threshold of the filter transmission approaches the limit of the spectral sensitivity of the film, the filter factor will increase more and more rapidly. Thus, the "A" Factor Ratio for Wratten filter #89 (see transmission curve, figure 1) is approximately 50, while the "A" Factor Ratio for filter RG5 is only 19.2. An exposure made through filter #89 would, therefore, need to be about two and one-half times as long as one made with the same lighting through filter RG5 at the same aperture. At the same time, the contrast gained would be too small to compensate for the increase in the filter factor.

Although the Wratten filter #70 (see transmission curve, figure 1) was not used in the work reported here, it can be used for the same purpose as the RG5 filter. The "A" Factor Ratio has been measured and found to be 27.5. This number is somewhat larger than the corresponding figure for the RG5 filter but not so great as to make the exposures prohibitively long.

CHOICE OF FILTER FOR PHOTOGRAPHIC SEPARATION OF LIVING AND DEAD LEAVES IN MONOCHROME

The following list is not intended to be regarded as complete. It contains only the names and descriptions of the filters actually tested in these experiments and a few others whose properties are well known.

The transparency of colored glass filters depends upon the thickness of the plates and hence the factor ratios given here for the Jena filters should be used only with plates 2 mm. thick. Due to difficulties in manufacture, filters made from different lots of material do not always possess exactly the same transparency. This is true of both gelatine and glass filters. Such variations as do occur will not cause any serious difficulty in the use of filters for ordinary photography. If, for example, it is found that a factor ratio given in this report leads to the production of negatives that are too thin, a few trials in which the factor ratio is increased slightly will quickly lead to the discovery of the correct ratio for the particular filter being used.

The factors and factor ratios given here have been calculated to apply to Eastman Supersensitive Panchromatic cut film. They are not correct for other types of emulsion and are not necessarily correct for panchromatic emulsions made by other manufacturers.

It is not possible to give a simple rule for selecting the proper filter to use in every case. Often more than one of the filters named might be found to be suitable and choice would then depend upon local conditions prevailing at the time the exposure is made. The degree of contrast desired is also a determining factor.

When selecting a filter from those listed in table 3, it will be helpful to keep the following general observations in mind:

The filters are listed in the table in the order of increasing contrast. They may be roughly classified according to their properties into three groups, the first group being comprised of Wratten № 25 and Jena RG1: the second of Wratten № 29; and the third group of Jena RG5 and Wratten № 70.

There is little choice between the filters in the first group as far as degree of contrast they afford is concerned. The factors for both are relatively low, which fact recommends these filters for photographs demanding short exposures. They find their best use in rendering sharp contrast in those subjects in which the reds and browns are very bright in comparison to the greens. They are not suitable, however, for sub-

jects in which this order of brightness is reversed. It will frequently be found difficult to obtain sharp contrast in close-ups made with either of these filters.

What has been said regarding the filters in the first group applies in somewhat lesser extent to Wratten #29. This filter is moderately fast and, under slightly adverse conditions, will yield better contrast than Wratten #25 or Jena RG1.

Both the filters in the third group reduce the effective sensitivity of the film very greatly, hence, their very high factors. They are, however, excellent for rendering strong contrast between greens and browns even under poor light conditions. In general views high contrast will be shown between objects in the foreground as well as in the background.

TABLE 3

Red filters capable of rendering reds and browns as highlights and greens as shadows

NAME	MATERIAL	WAVE LENGTH AT TRANSMISSION THRESHOLD	"A" FACTOR RATIO (DAY LIGHT)	USUAL FACTOR RANGE (DAY LIGHT)
		mμ		
Wratten #25 ("A")	Dyed gelatine	580		4–6
Jena RG1	Glass	590	1.15	4.6–6.9
Wratten #29 (F)	Dyed gelatine	600		6–8
Jena RG5	Glass	649	19.2	77–115
Wratten #70 (Contrast R)	Dyed gelatine	649	27.5	111–165

In this regard, filters RG5 and #70 are markedly superior to those of the first two groups. Filters RG5 and #70 are admirably suited for showing contrast in close-ups. Of the two filters of the third group, Jena RG5 is to be preferred to Wratten #70 on the ground that it will yield practically the same contrast as the latter with considerably shorter exposure. The most serious objection to the use of either of these filters is the length of the exposures they necessitate. This difficulty can, however, be minimized by working in strong light and by using as large a lens opening as the type of subject and depth of focus required permits. It is true that when using a large lens aperture it is necessary to focus more accurately than when a small stop is employed, but this presents no real difficulty. In order to obtain greater depth of focus with a large aperture, it is sometimes possible to move the camera

further from the subject. This expedient renders the image smaller and hence is of limited application when contact prints must be used. This objection is of less importance, however, if the prints can be made by projection.

The Jena filters have a distinct advantage over the Wratten filters in that they are made entirely of glass. They are not harmed at all by moisture and will withstand much higher temperatures than the gelatine filters. They are also very stable to irradiation and are unaltered by long exposure to strong light.

In order to obtain the best contrast and to shorten the exposure as much as possible, photographs made with red filters should be taken in strong light. Direct sunlight is better for the purpose than diffused light.

Clear sky frequently prints almost black in photographs made with red filters. Dark appearing skies can generally be avoided by making the exposures in the late afternoon when the sky contains a large proportion of red light. The image of the sky is lightened in the print by the presence of smoke haze in the atmosphere at the time the film is exposed.

When photographing for contrast, over-exposure should be avoided and it is usually better to allow only slightly more than the minimum exposure time rather than to run the risk of lessening the contrast by over-exposure.

SUMMARY

A method has been devised for determining photographic filter factors from the equal energy spectrum sensitivity curve for the particular emulsion to be used, the radiant energy curve of the light source to be employed, and the transmission curves for the filters. An expression called the Factor Ratio has been derived by means of which the filter factor data relating to a particular emulsion may be applied to a similar but not identical emulsion. Several filter factors and factor ratios calculated by the method outlined here have been tested in use and have been found to be correct.

A limited number of red filters suitable for rendering strong monochromatic contrast between green and brown or red foliage have been tested. Their properties are described and samples of work done with them are included in this report. The report contains some general suggestions for selecting and using red filters in separating greens and browns photographically.

ACKNOWLEDGMENTS

The author is indebted to Mr. Walter Clark of the Eastman Kodak Company Research Laboratories for the spectral sensitivity data covering the films used in this study, and to the College of Agriculture of the University of California for the use of its facilities in the conduct of this work.

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(1) Wratten Light Filters, 11th edition Revised, Eastman Kodak Company, Rochester New York. 1932.
(2) An Experimental Study of Several Methods of Representing Photographic Sensitivity. Raymond Davis and Gerald Kent Neeland. U. S. Bureau of Standards Journal of Research, Volume 7. 1931.
(3) Technical Data Weston Photronic Cell, Weston Electrical Instrument Company, Newark, New Jersey. Feb. 1935.

BOTANICAL PHOTOGRAPHY WITH INFRA-RED LIGHT*†

SILVESTR PRÁT

Prague, Czechoslovakia

Photographic plates and films which are sensitive to red and infra-red radiations have been much improved in recent times and are now obtainable from a number of manufacturers. Therefore, photography with infra-red rays may easily be used in any laboratory and may prove to have wide application. Pictures obtained by means of invisible radiations serve not only as illustrations and as records but also widen the possibility of direct observation and study. Photography of this type may therefore be considered a special method of investigation.

Laboratories have used photography with ultra-violet rays for more than thirty years. By means of the specific absorption of the ultra-violet light it has been possible to reveal important details which could not be detected by direct observation. Not very much is known about the specific absorption of the infra-red by the different parts of the cell. Generally it may be said that the infra-red rays are more pervasive than the visible and ultra-violet radiations. Nevertheless, specific absorption of the infra-red bands does occur, as shown, for instance, for water, chlorophyll solutions and many other compounds (Henri). These phys-

* From the Laboratory of Plant Physiology, Charles University. Praha.
† Received for publication March 28, 1936.

ical measurements are not as yet used in biological photography but show possibilities for further development by application.

The technique of infra-red photography is very simple. Only a proper filter (Wratten, Ilford, Zeiss or Agfa) and the special photographic plates or films are necessary. Only in this does it differ from ordinary photography. The plateholders should be loaded and the plates developed in complete darkness. Any strong light source with the proper filter may be used (Cfr. Jour. of the Bio. Photo. Asso. 4, 108, 111, 1935).

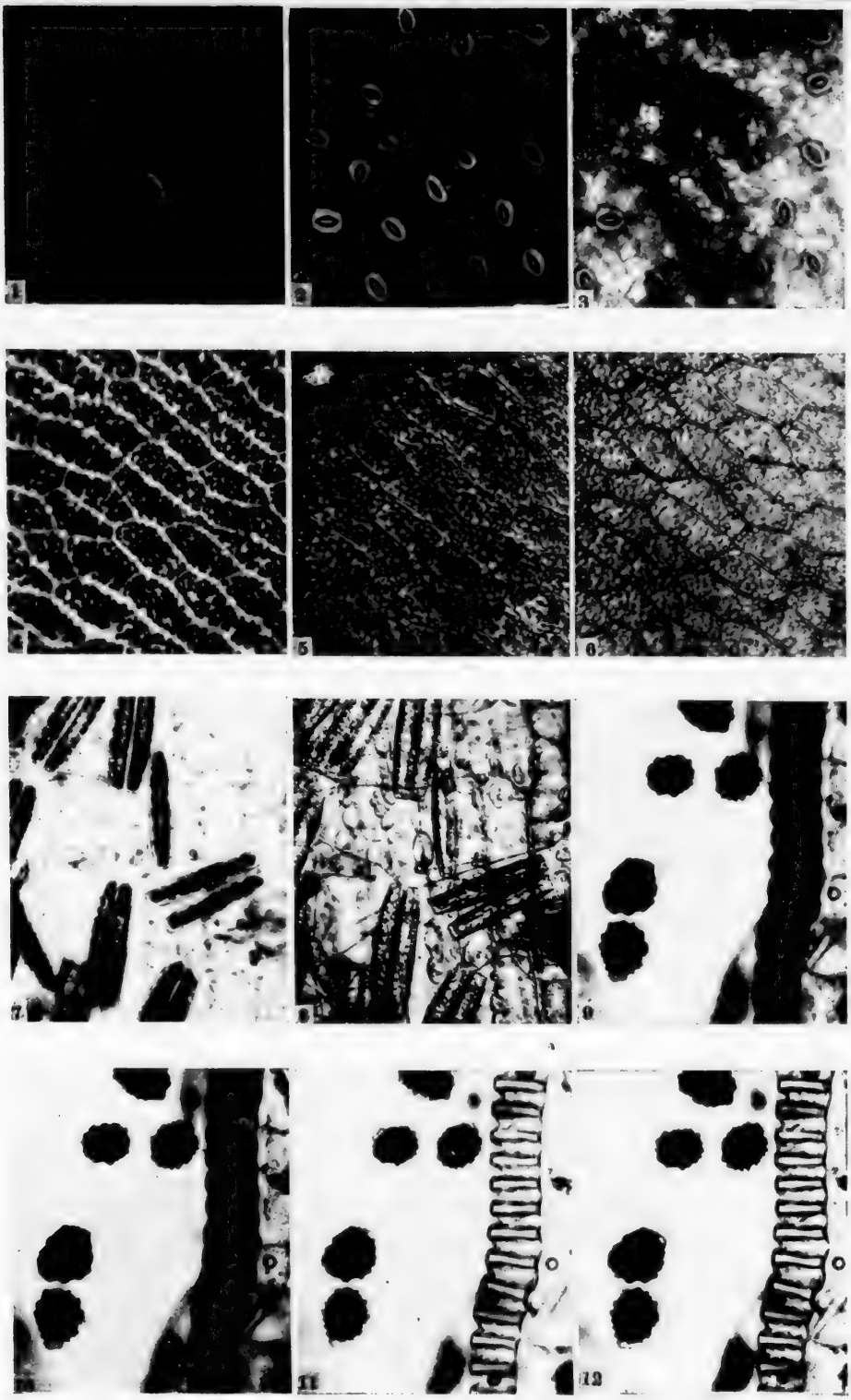
Correct focusing with invisible rays is very important. This is much easier with infra-red than with ultra-violet. The mathematical calculation method may be employed but is not very useful in practice.

TABLE I

NUMBER	OBJECT	LIVING	PLATE	FILTER	EXPOSURE
					seconds
1	Nymphaea alba. Young leaf	Living	Oi	0	8
2	Nymphaea alba. Young leaf	Living	Oi	m	16
3	Nymphaea alba. Young leaf	Living	810	42	16
4	Mnium undulatum. Phylloid	Living	Oi	0	1
5	Mnium undulatum. Phylloid	Living	810	42	2
6	Mnium undulatum. Phylloid	Living	810	84	20
7	Epithemia turgida	Living	Oi	0	1
8	Epithemia turgida	Living	810	84	20
9	Ceterach officinarum. Sporagium	Living	Oi	0	1
10	Ceterach officinarum. Sporagium	Living	Oi	m	2
11	Ceterach officinarum. Sporagium	Living	N	42	4
12	Ceterach officinarum. Sporagium	Living	810	84	20

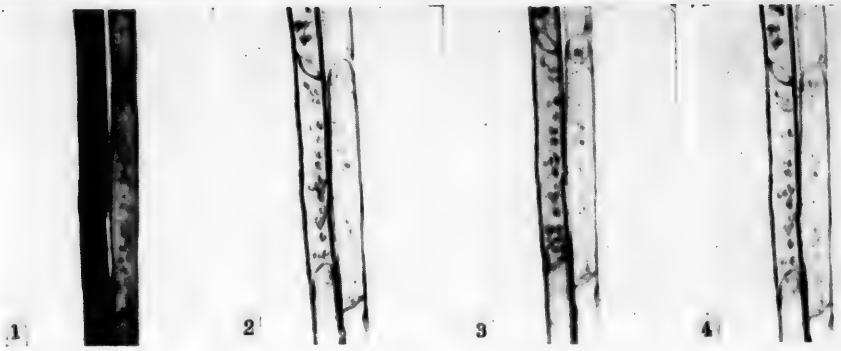
Direct focusing with red light presents no difficulties and the differences between red and infra-red are slight. Therefore the double filter by Zeiss is convenient, enabling focusing with red light and the addition of the second filter to exclude the visible radiations. This holds for macrophotography as well as photomicrography. It is important with thick microscopic sections or gross mounts to try several exposures at different focal levels (Massopust). However, with thin microscopic sections, in special cases, serial photographs with slight differences in the focusing levels may also be of great value.

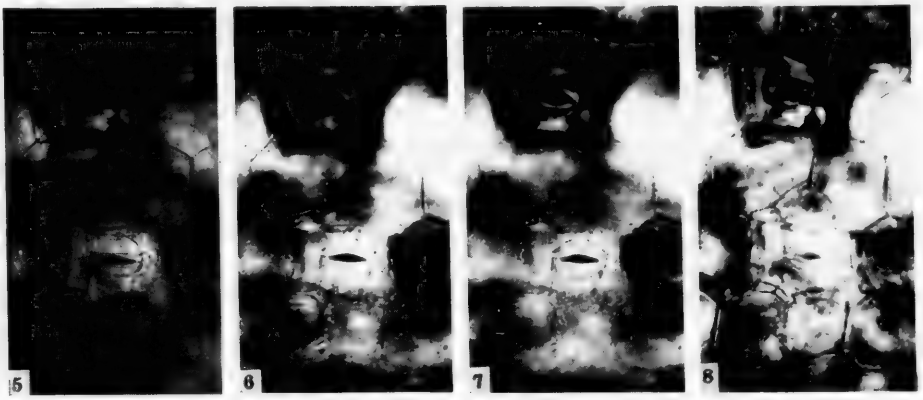
Photographs by reflected light on infra-red materials have proved a very useful method for some cases in medicine (Massopust), zoology

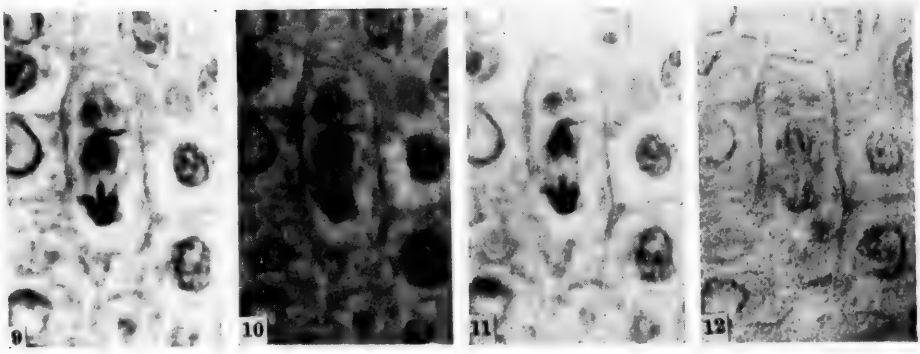


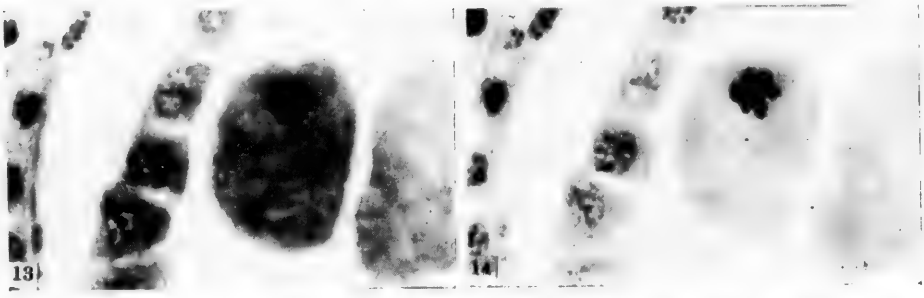
Protoplasma, Band XXII, S. Prat and K. Hruby, Gebrüder Borntraeger, Leipzig

ILLUSTRATIONS FOR TABLE I









Protoplasma, Band XXII, S. Prat and K. Hruby, Gebrüder Borntraeger, Leipzig

ILLUSTRATIONS FOR TABLE II

(Kraft), botany (Prát, Tonzig and Viterbi), phytopathology (Bawden, Eggert), paleobotany (Eggert, Walton). In microscopy, infra-red photography with transmitted light can in many cases be of great value with fixed and stained preparations (Preissecker, Prát and Hrubý), as in living objects (Prát and Hrubý).

TABLE II

NUMBER	OBJECT		PLATE	SCREEN	EXPOSURE
					seconds
1	Mnium undulatum. Rhizoid	Living	Oi		1
2	Mnium undulatum. Rhizoid	Living	810	84	20
3	Mnium undulatum. Rhizoid	Living	N	42	4
4	Mnium undulatum. Rhizoid	Living	810	42	2
5	Tradescantia zebrina. Leaf	Living	Oi	θ	3
6	Tradescantia zebrina. Leaf	Living	810	42	2
7	Tradescantia zebrina. Leaf	Living	N	42	4
8	Tradescantia zebrina. Leaf	Living	810	84	60
9	Vicia faba. Root section 7 μ	Fix. Nawaschin stained Cajal-Brožek	Oi	m	1.5
10	Vicia faba. Root section 7 μ	Fix. Nawaschin stained Cajal-Brožek	Oi	g	25
11	Vicia faba. Root section 7 μ	Fix. Nawaschin stained Cajal-Brožek	SS	m	0.75
12	Vicia faba. Root section 7 μ	Fix. Nawaschin stained Cajal-Brožek	810	84	20
13	Larix polonica 7 μ	Fix. Nawaschin stained Heidenhain	Oi	m	2
14	Larix polonica 7 μ	Fix. Nawaschin stained Heidenhain	810	84	30

The cell walls, especially when colored, are often much more transparent to infra-red rays than to visible light. Therefore, invisible details in the cells may be very distinct in photomicrographs made with infra-red rays as shown in the Figures (Table I, Figures 9–12, Table II, Figures 1–4). Good results are obtained from objects encrusted with

calcium carbonate (Corrals—Pax, calcareous algae, Corallina, Melobesia —Prát and Hrubý).

The most striking difference between photography in visible light and with infra-red rays is in cells with chloroplasts. As the pigments absorb most of the visible active light, the chloroplasts appear dark or black without structure on photographic prints when made with visible light. They are transparent for parts of infra-red radiation and therefore appear transparent or with definite structure (for red light cfr. Hubert.) (Table I, Figures 4–8.)

Contrary to the great absorption of ultra-violet radiation the nucleus and chromosomes are transparent to the infra-red rays. Therefore, only stained preparations can show details. In the staining with Heidenhain's iron-alum haematoxylin the chromosomes, centrosomes and pyrenoids take a brilliant black. The stained chromosomes do not transmit the visible light and therefore they appear in the photographic prints as dark or black spots without structure. When photographed with infra-red rays the appearance is quite different and in all investigated cases a dark surface can be seen surrounding the light outline. With Heidenhain's haematoxylin the cytoplasm often stains gray but it appears nearly colorless in prints photographed with infra-red rays. The method, therefore, is useful in many cases for obtaining clear prints (Table II, Figures 13 and 14).

It is very interesting that sections heavily stained with silver nitrate show much better details when photographed with infra-red than when photographed with visible light (Massopust, Figures 6 and 7).

The photographic method is very suitable for comparing the transparency of different organs of plants; the methods used by Linsbauer 30 years ago for measurements of light-transparency of green and white leaves did not find wide application. The extension of the photographic sensitivity into infra-red enables the application to organs not transparent to visible rays. In collaboration with Dr. T. Klášterský some experiments on the transparency of wood were made. First thin sections of wood, about 1 mm thick, were used. Contact impressions were made by placing the thin sections of wood in close contact with the photographic plate. The wood itself had the functions of a negative and a screen at the same time. When orthochromatic photographic plates were used little or no transparency of the wood to the light could be demonstrated. On the contrary, in the infra-red plates very distinct struc-

tures of the wood were shown. Considerable transparency of wood for infra-red was reported by Danckwortt and by Tonzig and Viterbí but no quantitative data was given.

To compare the transparency of different woods special wedges were used. Pieces of wood about 3 cm wide and 10 cm long were cut by Mr. Šantrůček in the form of wedges at 0 cm length 0 cm high (sharp edge), at 9 cm length about 8–9 mm high. Longitudinal tangential sections were employed. The wooden wedges were used directly as photometric screens in a specially constructed frame. A Philips Argenta lamp of 150 watts, dim (opal) glass and operated at 120 volts, 1 ampere, was used as the source of radiation. The distance was 2 m and the exposure was 6 seconds. Under these conditions the Agfa infra-red 810 Hart plates were blackened under the thickness of wood:

	mm.		*mm.*
Larix europaea	5–7	Carpinus betulus	2–3
Abies alba	6–7	Fagus silvatica	3
Picea excelsa	6	Ulmus sp	(3), 1
Alnus glutinosa	5–6	Quercus sp	2
Tilia sp	4–6	Prunus domestica	1–2
Pinus sp	3–4	Prunus avium	1–1.5
Populus sp	4	Juglans regia	0.5
Acer sp	4		

None or only feeble penetration under the same conditions of light was registered when René Orthoiso plates or Foma Opus plates were used. When the time of exposure was increased 160 times the blackening did not reach that of the infra-red material. On the René Orthoiso plates the decrease of penetration was as follows: Abies, Larix, Picea, Tilia, Alnus, Populus, Pinus, Carpinus, Acer, Ulmus, Quercus, Fagus, Prunus avium, Prunus domestica, Juglans.

For animal organs differences in transparency under different physiological conditions are described. For leaves it may be stated that the young leaves are much more transparent than old leaves. For wood, too, experiments with young and old twigs, fresh and dried wood, in different seasons of the year would be necessary. Only considerably lower penetrability of the spring wood than that of summer rings can be noticed. This applies for the visible as well as for infra-red radiation.

The relation of blackening is not simple, as not only absorption of rays but the reflection, especially the diffraction and dissipation in the cell-

lumens and air-filled intercellular spaces, must be considered. From this point of view, the transparency measured on the blackening of the plate as results of all these components, is important.

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EXPLANATION OF FIGURES

All exposures were made in May, 1933 and December, 1933 with Zeiss-Hegener apparatus; lamp: Wotan-nitra 400 W; developer: metol-hydroquinone; time of development: 2 minutes, 30 seconds; objective: Zeiss Apo. 10; ocular: Zeiss K 20.

PLATES

René Ortho-Iso marked	Oi
Kodak Film panchromatic supersensitive	SS
Kodak Film panchromatic	N
Ilford Infra-red Plates	I R
Agfa 810 Platten (infra-red)	810

FILTERS

Zeiss, yellow mittel	m
Zeiss, green	g
Agfa 42 (red)	42
Agfa 84 (infra-red)	84
Zeiss (Doppelfilter) infra-red	i

A CAMERA SCALE ADAPTATION OF PHOTRONIC METER TO SCALE*†

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In clinical photography the great range of subjects and scale variations (from infinity settings to magnifications of 6 or 7 times or greater), which demands exactness in duplication is unknown in pictorial photography. This paper concerns the computation and use of a scale for the camera bed, designed to simplify this complex problem of relative size of image to object.

Two considerations enter into this range of scale; one is to be able to set up quickly and accurately to the desired scale; the other to make the proper allowance for exposure of the film.

Relative apertures, as marked on lenses, are not constant; as the distance between the lens and the film increases, the values decrease. Thus, stop f:4 (working at infinity) becomes f:8 at 1 to 1 (natural size).

In this paper, is presented a scheme for setting up to scale before focusing, and in the second part, a calculator for ascertaining the correct exposure time from the photronic reading, allowing for scale and a large range of films.

* From the Department of Photography, Stanford University Hospitals, Stanford University Medical School.

† Received for publication September 25, 1935.

For a lens of a given focal length, there is a definite distance from the lens to the focal plane for a given magnification. The formula is:

$$D = (R + 1) f$$

$$R = \frac{d}{D}$$

in which R = "times" (i.e. ratio) of enlargement; D = distance from lens to sensitive surface; d = distance from lens to subject; f = equivalent focus of lens. A table is given for several lenses (see table 1).

TABLE 1

Times enlargement or reduction

EQUIVALENT FOCUS		INF.	1/16	1/8	1/4	3/8	1/2	3/4	1	2	3	4	5	6	7
3	d	INF.	51	27	15	11	9	7	6	4 1/2	4	3 3/4	3 3/5	3 1/2	3 3/7
INCH	D	3	3 3/16	3 3/8	3 3/4	4 1/8	4 1/2	5 1/4	6	9	12	15	18	21	24
4.3	d	INF.	73.08	38.712	21.5	15.765	12.9	10.33	8.6	6.45	5.733	5.375	5.16	5.016	4.914
INCH	D	4.3	4.568	4.837	5.375	5.912	6.45	7.525	8.6	12.9	17.2	21.5	25.8	30.1	34.4
13.5	d	INF.	229.48	121.44	67.5	49.5	40.5	30.166	27.0	20.25	18.0	16.875	16.2	15.75	15.428
CM.	D	13.5	14.343	15.187	16.875	18.562	20.25	22.625	27.0	40.5	54.0	67.5	81.0	94.5	108.0
7 1/2	d	INF.	127 1/2	66	37 1/2	27 1/2	22 1/2	17 1/2	15	11 1/4	10	9 3/8	9	8 3/4	8 4/7
INCH	D	7 1/2	7 31/32	8 7/16	9 3/8	10 5/16	11 1/4	13 1/8	15	22 1/2	30	37 1/2	45	52 1/2	60
8 15/32	d	INF.	144	74 7/32	42 17/64	31 3/64	25 13/32	19 49/64	16 15/16	12 45/64	11 19/64	10 19/32	10 5/32	9 7/8	9 11/16
INCH	D	8 15/32	9	9 17/32	10 9/16	11 41/64	12 45/64	14 53/64	16 15/16	25 13/32	33 7/8	42 11/32	50 13/16	59 9/32	67 3/4
12	d	INF.	204	108	60	44	36	28	24	18	16	15	14 2/5	14	13 5/7
INCH	D	12	12 3/4	13 1/2	15	16 1/2	18	21	24	36	48	60	72	84	96
18	d	INF.	306	162	90	66	54	42	36	27	24	22 1/2	21 3/5	21	20 4/7
INCH	D	18	19 1/8	20 1/4	22 1/2	24 3/4	27	31 1/2	36	54	72	90	108	126	144

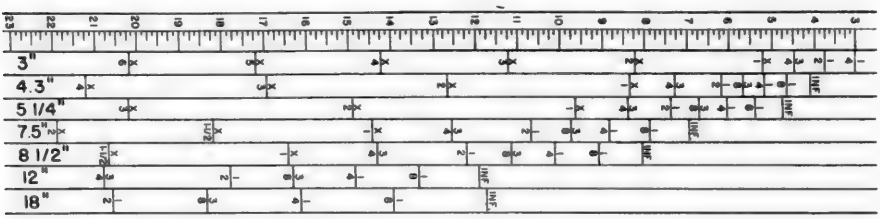

FIG. 1

If one lays off these distances on the ways of a view camera, then the film holder can be set at any chosen scale from infinity down to 1 to 1, 2 to 1, or however large the extension will cover for the lens chosen. A 3″ lens using a 24″ bellows extension will give about a 7 times enlargement.

The only requirements in using a scaled camera are: Lens board and plate holder must lock to the chosen extension, and the camera must be focused by moving the whole thing nearer to or farther from the subject.

Figure 1 is a reproduction of the camera base scale made for the author's group of lenses, covering a range of scale for all lenses (excepting 3″ infinity setting) from infinity to the greatest magnification obtainable with the 24″ bellows extension. This scale is used on an Eastman view camera No. 2-D and is equipped with interchangeable lens boards.

For each lens, one or two points were marked off for a given one or two scales as measured on the ground glass; the rest were obtained by calculation. At the extreme left of the camera base scale, was added a scale of inches divided in eighths. This is sometimes convenient for noting the scale when it happens to fall between two given magnifications. Negative envelopes were marked with all necessary data as well as the lens used, the photronic light reading, and the scale at which the picture was taken. To duplicate a photograph, at a later date, it is only necessary to refer to previous negative data, and set up accordingly.

ADAPTATION OF PHOTRONIC METER TO SCALE

Clinical photography also offers perplexing problems in the matter of correct exposure at varying scales, the inability to place light units in a fixed position, thereby eliminating the possibility of correctly charting the exposure time. This becomes still more complicated by the use of several different types of film with speed ratings of from very slow to extremely fast.

Exposure by guess is doomed to failure. For even in years of practice the photographer can hardly gain enough experience over the very wide range covered by clinical photography in variety of film, lighting, and color (photographic brightness) of subject. The last item makes one choose a meter to measure not the illumination of the subject by the incident light, but rather the illumination by the light *reflected from* the subject.

The Weston photronic meter is the author's choice. It reads directly in foot candles of illumination reflected from the subject. With but one or two exceptions, it covers well the range of lighting used in clinical photography. These exceptions being light transmitted through dense x-ray films, and ground-glass readings in photomicrography.

The photronic meter has inserted in front of the electric eye, a honey-

comb screen designed to keep out all light except that reflected from a 60 degree cone. Therefore, no light more than 30 degrees from center reaches the meter. From there into the center of the field, the relative importance of brightness of subject in producing the meter reading increases, giving the greatest weight to the illumination arriving axially.

This makes it important to use the meter at a distance from the subject, so that the 60 degree cone covers the region desired on the negative. A good rule to follow is, when taking the reading, to hold the meter at no greater distance away from the subject than its shortest dimension, and parallel to its surface. Care must be taken in not placing the meter so close that it will obstruct the light rays cast upon the subject, thereby casting a shadow and greatly reducing the light reading. By moving the meter back and forth, any shadow cast will immediately register upon the very sensitive meter dial.

A small light subject before a dark back drop, or a small dark subject before a light back drop are extreme examples. Unless care is taken in correctly placing the meter so that the back drops are, if possible, completely cut out, it would be possible either to over or under expose the subject many times. In this case the advisability of pointing the meter straight at the subject, or parallel to it is emphasized. This consideration speaks against the use of the former Weston meter, No. 617 Type 1, with two eyes 4 inches apart, because they cannot both be pointed at a small object which is very close.

The films chosen and rated at speeds as listed in the Weston meter manual are those which were found suitable, and cover, without exception, this large range of subjects. They appear in chronological order beginning at the top with the slowest used; Eastman lantern slide plates with a speed of $\frac{1}{1}\frac{1}{2}$, to super sensitive panchromatic emulsions, with speed ratings of 16. (Note this listing on extreme left of Figure 1.)

In addition to the column at the extreme left, wherein the films are listed, the calculator is made up of six circular areas, some of which are identical with those on the Weston meter. Reading from the left to the center, they will be referred to in this paper as Circles No. 1, 2, 3, 4, 5, 6. No. 7 is the semi-circular flashlight exposure guide. Comparing these individually with the Weston meter calculator, circle one shows the light values corresponding to those on the meter, except that they have been carried down to a low register of $\frac{1}{4}$ foot candles and also up to 4000 foot candles. In the more sensitive meter, these extreme low and high

readings will be of value, but in the model 617, they will be of little use.

Circle No. 2 lists the film speeds as rated by Weston. They have been carried to the extremely low rating of $1\frac{1}{2}8$; however, the lowest used here is $1\frac{1}{2}$, namely, lantern slide plates—slow.

Circle No. 3 represents the time in seconds, which has been considerably altered to suit individual needs, such as long exposures in excess of 64 seconds. Weston gives from $8\frac{1}{0}0$ of a second to 64 seconds. There is little occasion to use such fast shutter speeds, so it has been changed to read from $2\frac{1}{0}0$ of a second to 1000 seconds. This is a decided advantage because it eliminates all long-exposure calculations.

Circle No. 5 shows the normal setting, around which all these calculations are based. (Settings for weak contrast, strong contrast, darkest objects under-exposed and brightest objects over-exposed, appear in their proper place as shown on the Weston meter. The author will not go into a discussion of uses for these settings. This has been done most thoroughly in the Weston meter manual and can be used in conjunction with this calculator, should one care to do so.)

The black pointers indicate the settings to be used at the scale appearing opposite in circle No. 6. As discussed in Part 1, the effective aperture of the lens diminishes for increasing magnification, and this circle corrects for this effect from ratios $\frac{1}{16}$ actual size (call it infinity) through life size (1 to 1) up to a magnification of 7 times natural size.

Semi-circle No. 7 is a list of diaphragm openings for photo-flash bulbs, used with supersensitive panchromatic films and Agfa color plates. One No. 20 photo-flash lamp in suitable reflector, at a given distance from bulb to subject, and at a chosen magnification was employed. The panchromatic stops are listed under the letter "P" and the Agfa color plates under the letter "C". This chart has no direct bearing on the calculator, other than that it was thought an ideal place to list these data in conjunction with the camera scale and its relationship to size of image. The convenience of having this always at hand, must not be overlooked. On the opposite side of semi-circle No. 7 are the relative daylight speed listings for the commonly used films.

To find the correct stop, choose the distance from the subject to flashlight bulb (this distance must be measured). While the distance chosen will depend upon the area of the subject, it should be one of those listed at the heading of this chart—say 8 feet. Place the flashlight stand at this distance from the subject, lock the camera for chosen magnification,

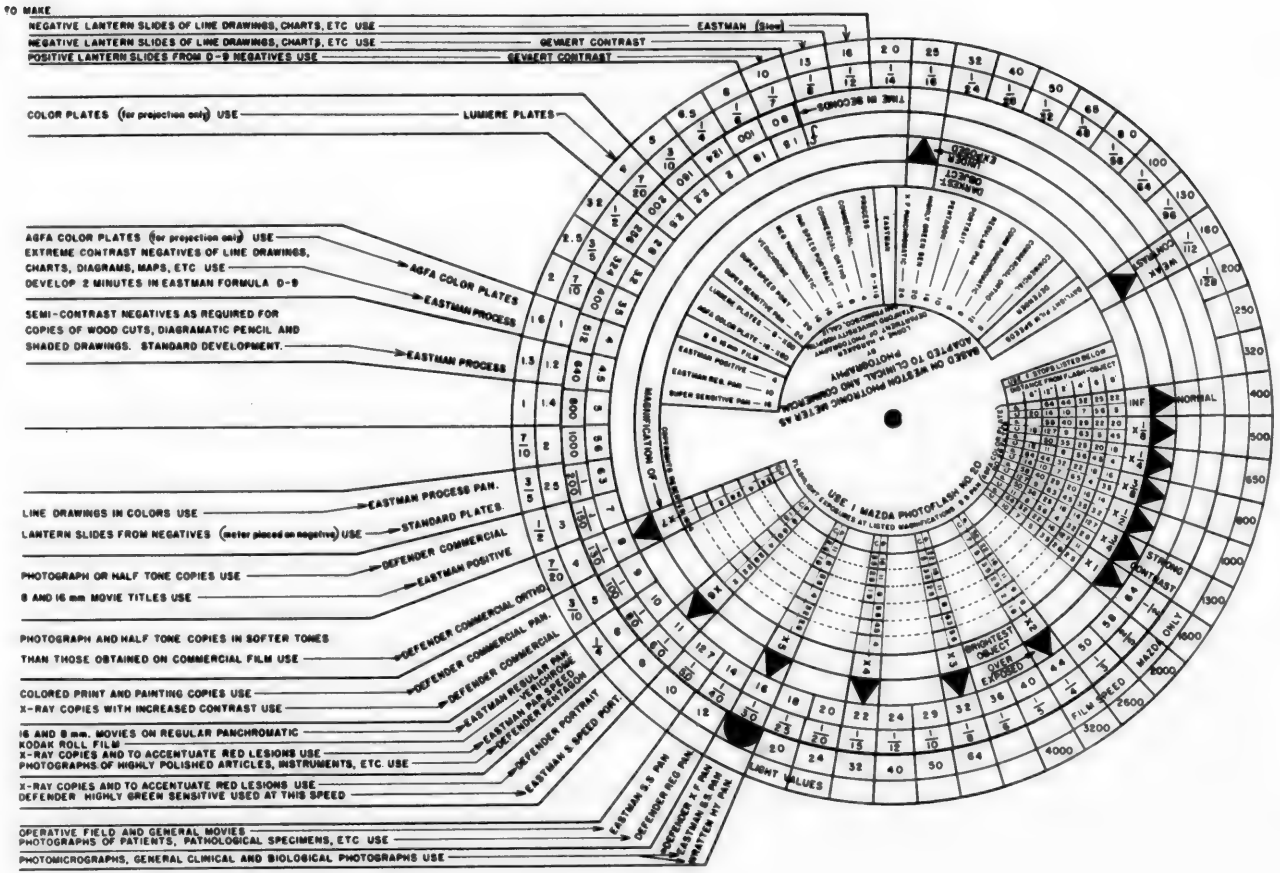
TO MAKE
NEGATIVE LANTERN SLIDES OF LINE DRAWINGS, CHARTS, ETC USE
EASTMAN (Slow)
NEGATIVE LANTERN SLIDES OF LINE DRAWINGS, CHARTS, ETC USE
GEVAERT CONTRAST
POSITIVE LANTERN SLIDES FROM D-9 NEGATIVES USE
GEVAERT CONTRAST
COLOR PLATES (for projection only) USE
LUMIERE PLATES
AGFA COLOR PLATES (for projection only) USE
AGFA COLOR PLATES
EXTREME CONTRAST NEGATIVES OF LINE DRAWINGS, CHARTS, DIAGRAMS, MAPS, ETC USE
DEVELOP 2 MINUTES IN EASTMAN FORMULA D-9
EASTMAN PROCESS
SEMI-CONTRAST NEGATIVES AS REQUIRED FOR COPIES OF WOOD CUTS, DIAGRAMATIC PENCIL AND SHADED DRAWINGS. STANDARD DEVELOPMENT.
EASTMAN PROCESS
LINE DRAWINGS IN COLORS USE
EASTMAN PROCESS PAN.
LANTERN SLIDES FROM NEGATIVES (meter placed on negative) USE
STANDARD PLATES.
DEFENDER COMMERCIAL
PHOTOGRAPH OR HALF TONE COPIES USE
EASTMAN POSITIVE
8 AND 16 mm MOVIE TITLES USE
DEFENDER COMMERCIAL ORTHO
PHOTOGRAPH AND HALF TONE COPIES IN SOFTER TONES THAN THOSE OBTAINED ON COMMERCIAL FILM USE
DEFENDER COMMERCIAL PAN.
DEFENDER COMMERCIAL
COLORED PRINT AND PAINTING COPIES USE
EASTMAN REGULAR PAN
X-RAY COPIES WITH INCREASED CONTRAST USE
VERICHROME
16 AND 8 mm. MOVIES ON REGULAR PANCHROMATIC KODAK ROLL FILM
EASTMAN PAN SPEED
X-RAY COPIES AND TO ACCENTUATE RED LESIONS USE
PHOTOGRAPHS OF HIGHLY POLISHED ARTICLES, INSTRUMENTS, ETC USE
DEFENDER PENTAGON
DEFENDER PORTRAIT
X-RAY COPIES AND TO ACCENTUATE RED LESIONS USE
DEFENDER HIGHLY GREEN SENSITIVE USED AT THIS SPEED
EASTMAN S SPEED PORT.
OPERATIVE FIELD AND GENERAL MOVIES
PHOTOGRAPHS OF PATIENTS, PATHOLOGICAL SPECIMENS, ETC USE
EASTMAN S.S. PAN
DEFENDER REG PAN.
PHOTOMICROGRAPHS, GENERAL CLINICAL AND BIOLOGICAL PHOTOGRAPHS USE
DEFENDER X-F PAN
EASTMAN G.S. PAN
GRAFFEX HY PAN
TIME IN SECONDS
CAMERA OBJECT
EXPOSURE
MADE ON WESTON PHOTRONIC METER AS ADAPTED TO CLINICAL AND COPHOTOGRAPHY
BY
PROFESSOR OF PHOTOGRAPHY
EASTMAN
PROCESS
COMMERCIAL ORTHO
PANCHROMATIC
PORTRAIT
SUPER SENSITIVE PAN
SUPER SPEED PORTRAIT
VERICHROME
AGFA COLOR PLATES — 10-120
EASTMAN POSITIVE — 6
EASTMAN REG. PAN — 10
SUPER SENSITIVE PAN — 16
MAGNIFICATION OF
USE 1 MAZDA PHOTOFLASH NO 20
FOCUS SCALE
USE 4 STOPS LISTED BELOW
INF
NORMAL
STRONG CONTRAST
MAZDA ONLY
FILM SPEED
LIGHT VALUES
BRIGHTEST OBJECT OVER EXPOSED

FIG. 2

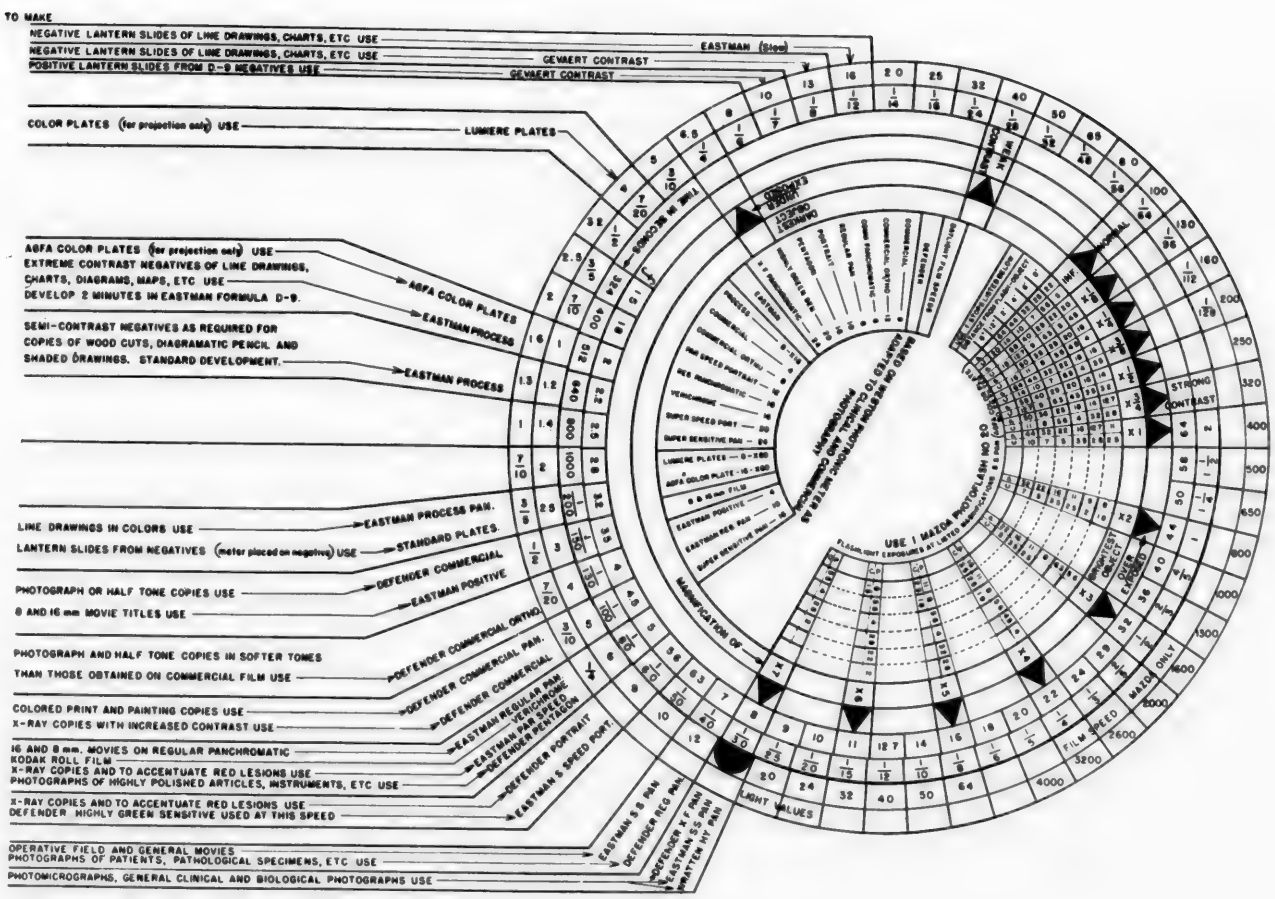
TO MAKE
NEGATIVE LANTERN SLIDES OF LINE DRAWINGS, CHARTS, ETC USE
NEGATIVE LANTERN SLIDES OF LINE DRAWINGS, CHARTS, ETC USE
POSITIVE LANTERN SLIDES FROM D-9 NEGATIVES USE
EASTMAN (Slow)
GEVAERT CONTRAST
GEVAERT CONTRAST
COLOR PLATES (for projection only) USE
LUMIERE PLATES
AGFA COLOR PLATES (for projection only) USE
EXTREME CONTRAST NEGATIVES OF LINE DRAWINGS, CHARTS, DIAGRAMS, MAPS, ETC USE
DEVELOP 2 MINUTES IN EASTMAN FORMULA D-9.
AGFA COLOR PLATES
EASTMAN PROCESS
SEMI-CONTRAST NEGATIVES AS REQUIRED FOR COPIES OF WOOD CUTS, DIAGRAMATIC PENCIL AND SHADED DRAWINGS. STANDARD DEVELOPMENT.
EASTMAN PROCESS
LINE DRAWINGS IN COLORS USE
EASTMAN PROCESS PAN.
LANTERN SLIDES FROM NEGATIVES (meter placed on negative) USE
STANDARD PLATES.
PHOTOGRAPH OR HALF TONE COPIES USE
DEFENDER COMMERCIAL
8 AND 16 mm MOVIE TITLES USE
EASTMAN POSITIVE
PHOTOGRAPH AND HALF TONE COPIES IN SOFTER TONES THAN THOSE OBTAINED ON COMMERCIAL FILM USE
DEFENDER COMMERCIAL ORTHO
DEFENDER COMMERCIAL PAN.
DEFENDER COMMERCIAL
COLORED PRINT AND PAINTING COPIES USE
EASTMAN REGULAR PAN
X-RAY COPIES WITH INCREASED CONTRAST USE
YEN RICHROME
EASTMAN PAN SPEED
16 AND 8 mm. MOVIES ON REGULAR PANCHROMATIC
KODAK ROLL FILM
DEFENDER PENTAGON
X-RAY COPIES AND TO ACCENTUATE RED LESIONS USE
PHOTOGRAPHS OF HIGHLY POLISHED ARTICLES, INSTRUMENTS, ETC USE
DEFENDER PORTRAIT
X-RAY COPIES AND TO ACCENTUATE RED LESIONS USE
DEFENDER HIGHLY GREEN SENSITIVE USED AT THIS SPEED
EASTMAN S SPEED PORT.
OPERATIVE FIELD AND GENERAL MOVIES
EASTMAN S S PAN
PHOTOGRAPHS OF PATIENTS, PATHOLOGICAL SPECIMENS, ETC USE
DEFENDER REG PAN.
PHOTOMICROGRAPHS, GENERAL CLINICAL AND BIOLOGICAL PHOTOGRAPHS USE
DEFENDER X-F PAN
EASTMAN S-S PAN
PRINTED HY PAN
BASED ON METRIC PHOTRONIC METER AS ADAPTED TO CLINICAL AND COPYING PHOTOGRAPHY
USE 1 MAZDA PHOTOFLASH NO 3 OR 3 B
FLASH-LIGHT EXPOSURES AT LISTED SHUTTER SPEEDS
MAGNIFICATION OF
LUMIERE PLATES — 0-250
AGFA COLOR PLATE - 16 - 250
8 & 16 mm FILM
EASTMAN POSITIVE — 4
EASTMAN REG PAN — 10
SUPER SENSITIVE PAN — 20
SUPER SPEED PORT — 20
SUPER SENSITIVE PAN — 20
VERICHROME
HIS PANCHROMATIC
HIS PANCHROMATIC
FILM SPEED
LIGHT VALUES
STRONG CONTRAST
MAZDA ONLY

FIG. 3

and then focus the image upon the ground glass by moving the camera. Should it be $\frac{1}{4}$ size, then under the X $\frac{1}{4}$ column and following it across to the 8 foot distance column, the stop listed under column "P" (panchromatic film being used) would be the one to use—namely f:18. The same ruling applying for color plates (Agfa) under like conditions would require a stop of f:4.

Should you wish to use a film other than supersensitive panchromatic, count off the number of spaces in the film speed circle between speed 16 (which is the speed of S. S. Panchromatic) and that of the selected film, then count off a like number of spaces in circle 4, which is the stop to be used for the film selected. Example: With flash bulb 4 feet away from the subject, and camera focused at infinity (using supersensitive panchromatic film) the correct stop would be f:32. To use Defender portrait film, which has a film speed of 8, a like number of spaces below f:32 would give f:22, which would be the stop to use for a film having a Weston speed rating of 8.

In operation, the calculator is very simple and extremely accurate. The author's series of test negatives taken under conditions generally encountered in clinical photography (including the copying of halftones, charts, x-ray films, etc.), give properly exposed negatives, and the densities are uniform regardless of the image size, whether it be $\frac{1}{16}$, 1 to 1, or greatly magnified.

Circles 1 and 2 are stationary; circle 3 comprises a rotating disk; circles 4, 5, 6 and 7 make up a second rotating disk. Figures 3 and 4 show quite clearly the method of operation cited in the foregoing example. In photographing a full length subject in which a general view is required (using supersensitive panchromatic film), the subject is first posed before the back drop and then the necessary light units placed as desired. Take the photronic reading, and as mentioned before, this reading must be taken with the meter held at no greater distance away from the subject than its shortest dimension; therefore, if one held the meter about 15 inches in front of the subject, the meter then would take the reading of the light reflected only from the torso of the subject—assume this reading to be 400 foot candles. The full length image appearing on the ground glass, according to the camera base scale, is $\frac{1}{16}$ actual size. The $\frac{1}{16}$ actual size is approximately infinity or normal setting. Set the semicircular film speed pointer to 16 (the speed of supersensitive panchromatic film). The normal or infinity pointer is then set to 400. Referring

to circle 4 (f. stops) and directly opposite in circle 3 are a number of combinations of stops and exposure times, any one of them giving the correct exposure. Should one want a closeup of a skin lesion upon the area from which the photronic reading was taken (this to be taken at

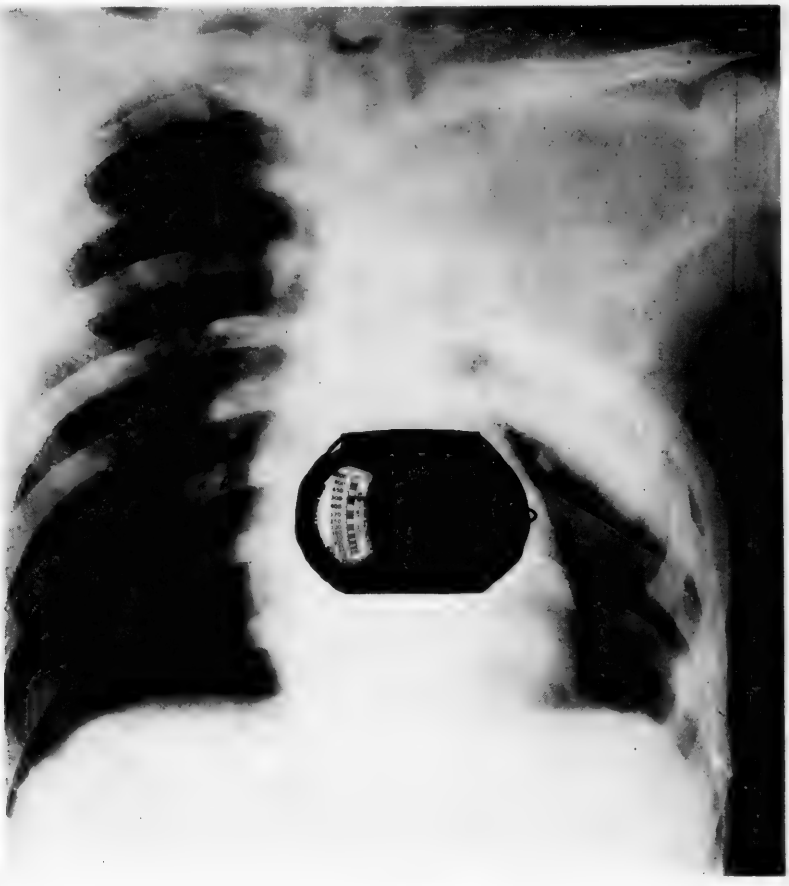

FIG. 4

actual size—1 to 1) assuming that the relationship between light units and subject has not been changed, the camera is first set to a scale of 1 to 1, then moved forward until the subject is in focus upon the ground glass. The calculator pointer opposite times 1 is then set at 400. The exposure time now is four times greater. In the first set up the exposure

time at f:16 was $\frac{1}{30}$ of a second while in the actual size photograph it is shown to be $\frac{1}{8}$ of a second at f:16. At times 2 the exposure would be $\frac{1}{4}$ of a second and so on up to times 7; at this setting the exposure would be 8 seconds.

The same procedure is followed in all phases of copy work. Merely select the film to be used, place the semicircular pointer to the correct film speed, setting the magnification pointer as read from the camera scale, then any one of the listed stops shown under this set up will give correct results.

To copy black and white charts, set the semi-circular pointer to Eastman Process film (which has a film speed of 1), and then proceed as outlined in the previous paragraph.

In making lantern slides photographically from negatives, place the meter on the negative over the illuminator to be used, reading the amount of light transmitted through the negative; however, care should be taken in placing the meter on the area most desired on the lantern slide. The author uses this system in the copying of x-ray films, especially when an almost indistinguishable area is to be shown. See Figure 4.

This system has proved to be a work saver and the item of waste material has been entirely eliminated.

Thanks are hereby extended to Dr. R. R. Newell, and Dr. Lewis Jacobs for their help and advice in this work.

SIMPLIFIED OFFSET LITHOGRAPHY

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When in 1796, Alois Senefelder discovered that a slab of porous stone could be etched and that ink impressions could be made on paper, the world little dreamed that these experiments were the beginning of an important process. These discoveries not only brought about lithography as an art but as a commercial printing process. The word "lithography" means writing on stone. It comes from the two Greek words *lithos*, meaning stone, and *grapho*, meaning write. The art and process of lithography is based on a simple chemical principal; the antagonistic qualities of grease and water. A lithographic stone can be drawn upon with a grease crayon and then dampened with water. When

an oily ink is spread over the stone it adheres only to the grease image, the water repelling the ink from the rest of the stone. When a piece of paper is pressed against the inked stone an impression of the drawing is left on the paper.

The crude method first discovered by Senefelder was carried on by more capable hands and lithography came into being. Then half a century passed with little if any improvement in the process.

Up to this time the subject had been etched on a cumbersome block of stone for use in a flat bed press. Then came the discovery that the subject could be drawn or photographed onto a flexible sheet of metal which could be attached to the cylinder of a rotary press. This improvement permitted the process to be speeded up considerably and so brought it within the reach of a much larger group of users.

Replacing the cumbersome blocks of stone with flexible sheets of grained metal was a great improvement, but more was yet to come. It was in 1855 that the offset principal was accidentally discovered. Up to this time lithography had been a direct reproduction process, but it was found that the offset feature added greatly to the beauty of the finished work. Offsetting made lithography an indirect process, the image not printing directly from the plate to the paper but first to a rubber blanket and then to the paper.

The demand for greater speed and lower production costs brought planography into being. Planography, though similar in principal, is not offset lithography. It is quick, cheap printing. Many small jobs of different types are grouped together in some instances and photographed and printed at one time, being cut apart after they are finished. By this method work is done at a very low cost. Although this method attracted many users it was apparent that the quality of the finished work was somewhat lower than many desired. The demand for a fast economical press similar to the big offset presses, only much smaller, arose among jobbers and also large concerns doing their own printing. Men in the United States and Germany went to work on a machine that would fulfil this demand, and small offset presses came into existence. These presses were much like the larger offset presses only they were considerably smaller and faster. They worked on the same principle and required skilled operators to secure good results. Here the builders of these new machines fell down. In their advertising they stressed the point that these presses were so simple to operate that the office boy could run

them, and they attempted to sell them as office equipment. Their line of reasoning must have been something like this: when the size of the press was reduced, that automatically made the whole process simpler. Their mistake was obvious and as office equipment these presses were a failure. Only a few experienced lithographers using them for small jobs that were needed in a hurry were successful. This fault was overcome in a machine called the Multilith. This press was built by a manufacturer of office printing machines and built with these ideals in mind: simplicity of operation; yet production of work comparable in quality to that of the larger presses. With this machine is used a special process which differs slightly from lithography and is suitable for use by laymen. Mr. A. C. Austin describes this process in his article "Photo Lithographic Methods," which appears in the December 1934 issue of the National Lithographer as follows: "a special Multilith process—a sort of hybrid between wet and dry lithography with a lot of useful points that might profitably be a part of general lithographic practice." These machines are so small that they are classed as office equipment. With air feeds they are capable of printing between five and six thousand copies an hour comparing favorably with any printing process.

The metal plate from which the printing is done is made of zinc, and is only five one-thousandths of an inch thick. The surface of this plate is grained so as to resemble the porous surface of a lithographic stone.

There are two methods of placing the image on the printing plate, namely the photographic and the direct image method. When preparing a plate by the photographic method, the subject is photographed to the desired size by a special camera. The negative obtained is placed on a printing plate that has been sensitized, or coated with a light-sensitive material. These are placed in a vacuum printing frame and exposed to the rays of an arc lamp. After exposing for the required length of time the plate is taken out of the printing frame, the negative removed from it, and the plate covered with a special developing ink. The sensitizer that has been affected by the light passing through the negative is rendered insoluble in water while that not touched by the light washes away easily. So when the developing ink is spread over the sensitizer it is quickly rubbed dry and the plate placed under running water. The ink holds firmly to the sensitizer and as this soluble coating is washed away the ink is carried with it. The sensitizer that has been hardened by the light remains fast, holding the ink also. It is this re-

maining ink-covered sensitizer which attracts the ink on the press and does the printing. After the plate is washed the image stands out clear and sharp.

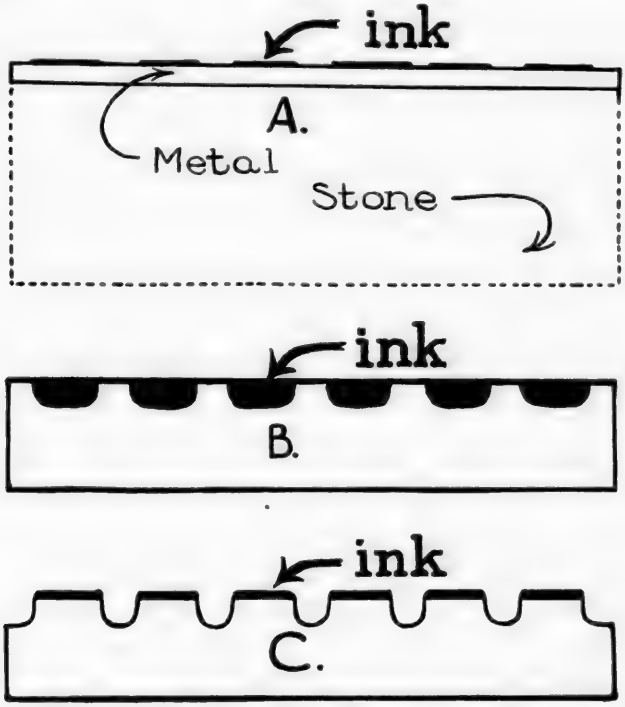

FIG. 1. Lithographic printing. This type of impression is produced from a flat metal or stone surface. Such a surface has neither raised nor recessed portions. Generally the impression is "offset" or printed from a metal surface to a rubber blanket before it reaches the paper. (Offset Lithography.)

B. Intaglio printing. Depressions are engraved or etched into a flat surface. Ink is rolled into these depressions and the raised surface is wiped clean. Pressure forces the paper into the depressed areas which draws out the ink giving the impression on paper. Copper and steel engraving, etching and photogravure employ this type of plate.

C. Letterpress printing. This type of printing is produced from relief or raised surfaces. The ink is placed on the raised surface with a composition roller. The plate then comes in contact with the paper, leaving the impression of the raised areas. Ordinary type, photo-engraved line and half-tone cuts and electrotypes are printed in this manner.

If the plate is to be run immediately it is treated with a mild etch which is merely wiped on with a piece of cotton. The plate is then wrapped around a cylinder on the press and the desired number of copies run off. If it is desirable to store the plate for future use, the ink is

washed off and a coating of gum wiped over the plate to protect the surface from air and moisture.

When preparing a plate by the direct image, or direct to the plate method, the plate is first cleaned and then may be placed in a typewriter and typed upon, or may be drawn or written upon with crayon or pen and ink. Then, placed on the press, the surface of this plate may be reproduced in any quantity.

A cross section of the production work in an average shop using one of these small presses presents an interesting picture. It shows successful competition with any of the other methods of reproduction. In the first place if cost comparisons are made with ordinary printing requiring type setting, wax plates, electrotypes, setting of rules, boxes, etc., offset printing costs run considerably less. On short runs this is a great advantage, inasmuch as the preparation of ordinary printing costs much more than the preparation of offset plates. On the other hand, should the run be a long one, the speed of the little press, combined with the economy in labor, lack of make-ready, form lock-up, etc., tend to keep offset costs at a minimum while yielding a finished job of true lithographic quality unapproachable by other methods.

The scope of work which can be handled to advantage by one of these machines can perhaps best be understood by taking a few specific examples.

The purchasing agent of some large company wants a booklet portraying the accomplishments of his organization for the benefit of the stockholders. There are some forty photographs and charts which must be included. But—here is the problem. Only seventy-five copies of this booklet are needed—just enough for the active stockholders. Photoengravings and zincs are prohibitive because of their cost. Here is the solution of the problem. By using typewritten copy for the text and placing the photographs and the charts in their proper places, the whole job is photographed, offset plates are made and run and there is the booklet complete. By employing this speedy little press using plates that cost very little, a job is created which otherwise would not exist at all.

Suppose the advertising manager wants to send out an illustrated sales letter. He wants it at once. The illustration that he has is a clipping from an old catalogue. He has neither the original nor the engraving and the letter must be folded and mailed by the following morning.

Here is what is done. The illustration is pasted in position on the letterhead and the letter is typed directly on it. Then, when the letter is signed the preparation of the original copy is complete. It is then photographed and transferred to the printing plate, ready to run in about forty minutes.

Not infrequently is the bookshop owner in possession of a pamphlet or booklet or even a rare illustration that is out of print. If additional copies are desired it is a simple matter to photograph the booklet, page by page, transfer to the printing plate and the entire edition run in short order. Illustrations can be reproduced so faithfully that the casual observer will find it hard to differentiate between the reproduction and the original.

One of these machines would be a valuable asset to the photographic department of any school or hospital. Being able to make his own negatives, the photographer could produce in any quantity reprints of articles, important pictures, etc. Laboratory manuals, instructions and examination sheets could be typed directly on the plate along with any chart or sketch that might be necessary and be reproduced in any quantity. He could also produce the school's stationery, including fine lithographed letterheads and envelopes as well as office forms. The ability to do such work would make a photographic department more valuable to any institution.

It seems difficult for anyone accustomed to the heavy involved machinery of ordinary printing and lithographic presses to imagine that one of these little machines is capable of producing such fine, high quality work.

REPORT OF THE COMMITTEE ON STANDARDS FOR MOTION PICTURES OF BIOLOGICAL MATERIAL

I. INTRODUCTION

The following report was made from suggestions of all members of the Committee. Unfortunately it was not possible for the Committee to meet as a whole but we have met in pairs for discussion. In addition the report has been submitted to a number of biologists interested in motion pictures and to several members of the Association. We have gained much from their constructive criticism.

Some matters are controversial and perhaps a few comments by the Chairman will be of interest. From the educational standpoint in biological science there seems to be no question that the 16 mm. size will be used for projection in offices and classrooms. The recent improved projectors using 750 and 1000 watt lamps give adequate pictures for as large audiences as are likely to be in the classroom or at society meetings. Many of the distributors listed in our second report sell and rent, exclusively, 16 mm. films, and at the present the committee knows of very few films not available in 16 mm. prints. This is true for many of the medical schools although some are equipped for 35 mm. films.

Sound films are not succeeding in attracting the attention of colleges and universities although they are proving useful at the lower levels of instruction. Except when the sound is essential (as listed in sec. 3 of our report) it is apt to be a drawback to general use of the film. The committee knows of no biology department of a college making regular use of sound films. Sounds on the theater screen are often faked; but such a procedure cannot be tolerated when scientific fidelity is required.

Many of the suggestions under the caption of *general criteria of excellence* may seem obvious to the advanced worker but the committee feels that such helps should be included for the aid of the beginner and of the teacher who wishes a broader basis for evaluating films. Almost all of these suggestions have been violated by persons whose professional attainment would seem to have precluded such lapses. The list may serve as a stimulating check list to the advanced worker. We must guard lest the stone become a boomerang! The suggestions regarding the titling of teaching films are the result of our attempts to get suitable films to use in the biology classes at Yale University, and are offered for the consideration of those who will make the superior films that we need so much. This summer the chairman of the committee saw one film that had no excuse for being four reels in length. There was nothing in it that could not have been shown better with lantern slides. Yet it was planned for a large laboratory and resulted in spoiling an evening for many of us. There are some biological subjects for which motion pictures are not desirable. At the present time too much poor animation prevails in teaching films. When it is less clear than would be the diagram of the average teacher, it should not be included. Some of you may feel that we are rash in listing subject matter. This is intended solely for its suggestive and heuristic value and is not in any way to re-

flect on individual liberty or initiative. We hope that the members will add to this list any omissions which have inadvertently been made.

There is a growing conviction among biologists that the characteristic technique of the professional screen is not adequate for biological problems; and that our Association should lead in developing motion pictures on a biological level.

The committee welcomes suggestions from the membership as to what we should do next that might be of the greatest value to our membership.

The report was discussed and approved at the Chicago Convention and with minor changes in style is here presented.

If you have films not listed in the first report of the Committee will you please send the titles and brief descriptions to the Chairman of the Committee?

II. STANDARDS PROPOSED FOR MOTION PICTURES OF BIOLOGICAL MATERIAL

1. Size. For general use the 16 mm. size will usually be found preferable because of lower cost and more generally available projection facilities. Modern 16 mm. projectors give adequate screen size and brilliancy.

For taking purposes the choice between 35 mm. and 16 mm. film depends on the subject and on the finances available. The 16 mm. film has proved adequate for taking many biological subjects.

It is recommended that 16 mm. prints of all subjects related to the biological sciences be available.

2. Color Films are preferable to black and white when the color of the objects photographed is an essential feature. As the technical difficulties are reduced, more use should be made of color processes. Judicious use of stained or toned film or toned positives relieves the monotony of black and white but any tendency toward "nature faking" is to be avoided.

3. Sound Films are of value for special programs and for historical purposes to bring to the audience the personality of a great person. They are valuable to record sound phenomena such as speech, animal sounds, diagnostic sounds, etc., when the original subject cannot be exhibited. Sound films otherwise will probably have little use in college and university teaching because of their inflexibility. They cannot be adapted readily to a given lecture or demonstration. Cutting and re-editing film with a sound track is a difficult and costly process. A course is successful to the extent that it is attuned to the time, place and students, and a sound film for one purpose may not be satisfactory for another purpose. This objection may be met in part by running the

sound film silently when the sound is inappropriate, or not required, provided the projector is so built as not to injure the film. As sound films project at a speed of 24 frames per second, more film must be used for the same interval of time. However, the pictorial material in both a silent and a sound film may be about the same because the titles in the silent film increase the length of showing when 16 frames are projected per second. Sound on discs is another solution of the flexibility problem as its use is adapted to both film speeds.

4. Silent Films will probably be used more frequently in class teaching except as noted in 3.

5. General Criteria of Excellence

A. Photographic technique.

i. Sufficient illumination and freedom from flicker (the last is especially objectionable in time lapse and animation techniques).

ii. Freedom from field jerks.

iii. Good placing and proper size of point of interest.

iv. Uniform backgrounds (especially when film from several similar subjects are to be combined, as is often the case in surgical films).

v. Correct composition and freedom from crowding. (The final size on the screen must be considered when the film is taken.)

vi. Adequate use of long shots and close ups to show orientation and detail. (Dissolves are a useful means of shifting from the normal to the abnormal, and vice versa.)

vii. Proper color value, definition and contrast, and freedom from flare.

viii. Proper use of accessories and related objects to produce a coordinated picture with respect to parts and to the entire film.

ix. Efficient use of special techniques (i.e., cinemicrography, dummy action, animation, accelerated or retarded motion, use of X-rays, stills, dissolves, etc.)

x. Freedom from spots, scratches, etc. (Meticulous care and vigilance are necessary to keep all equipment clean and in good operating condition.)

B. Presentation (*including editing*).

i. Consistent classification and transition from the general to the particular.

ii. Suitable spacing of striking phases to form climaxes.

iii. Adequate, properly arranged analytical and explanatory matter, adapted to the audience for which the film is planned.

iv. Good continuity. (This may require the use of two cameras, e.g., during a surgical operation.)

v. Absence of material unnecessary for good presentation.

vi. Self-explanatory titles easily read and less than 15–20 seconds long. Except for special instances one-half second per word is good. White block letters on a black field are very effective and the letters must be large enough to be readable at all audience distances. For long titles the moving script method is preferable.

vii. Scenes long enough to justify the title but not so long as to be tedious. (When necessary and possible, short shots should be repeated. Dissolves are useful when it is necessary to shorten a scene, e.g., the first suture may be shown at the end of a surgical operation and then dissolve into the last suture to avoid unnecessary repetition.)

C. When films are planned for educational purposes the titles should:

i. be adequate to name the film, to show the location of it in space and time, and to explain the script from which it was made.

ii. not be inaccurate or so detailed that the film cannot be adapted to different situations by means of running comment by the lecturer.

iii. be too few rather than too many when the film is to be used at the college or university level of instruction.

iv. give the proper generic and specific name to prevent the inevitable confusion from common names which usually change with locality.

D. Cutting and recutting should be continued until the film cannot be improved further by this means.

6. Subject Matter. Advantage of the motion picture technique should be taken to record what cannot be shown better or more easily by another method. A good motion picture must be more than a series of still subjects.

The film should conform to professional ethics and not contain undue commercial or personal advertising.

The material should be representative, rather than special or abnormal, when the film is intended for general use.

Suggested material:

A. Life of organisms in their natural environment or showing their adaptability to unusual conditions.

B. Analysis of living processes by means of speeding or slowing phenomena not clearly seen at their normal speed, e.g., (a) Animal and plant motions and behavior. (b) Developmental processes of both plants and animals. (c) Progressive reactions as in parasitism, disease, etc.

C. Demonstrations of processes which occur on too small a scale for presentation before an audience or for which there is only one suitable viewpoint.

D. For the demonstration of a process, apparatus and the proper techniques of investigation or presentation.

7. Intrinsic value of the finished film. The real value of a biological film depends on how well it succeeds in achieving in the best way the purpose for which it was made and can be decided only by audiences competent to judge its merits and effectiveness. Some films will have wide appeal while others must be restricted to small groups of specialists. With increased dissemination of knowledge the appeal of a really good film will increase; because what is specialized knowledge today becomes general knowledge tomorrow. Consequently, a film should be planned, when possible, so that it may make the greatest contribution to biology and medicine. Sometimes long technical films may be cut and re-edited into shorter versions of interest to more general audiences. Certainly recognition will come to the photographers responsible for the production of films of exceptional merit.

The items listed above are those which, in the opinion of the Committee, should lead to the production of successful films and give a basis for critical appraisal of biological motion pictures.

The Committee does not feel that methods for meeting these criteria should be included in this report and recommends that the qualified members of the Association do this for our JOURNAL. Such contributions will be of great value because of the relatively small amount of literature now available in this field.

Committee on motion pictures of the Biological Photographic Association.
K. K. BOSSE
JEAN KIEFFER
OSCAR W. RICHARDS, *Chairman*

PRINT CRITICISM

LOUIS SCHMIDT

New York, N. Y.

It has been stressed in a previous contribution that it is important to project on the focusing screen an image of not less than 8 inches in diameter when using a 5″ x 7″

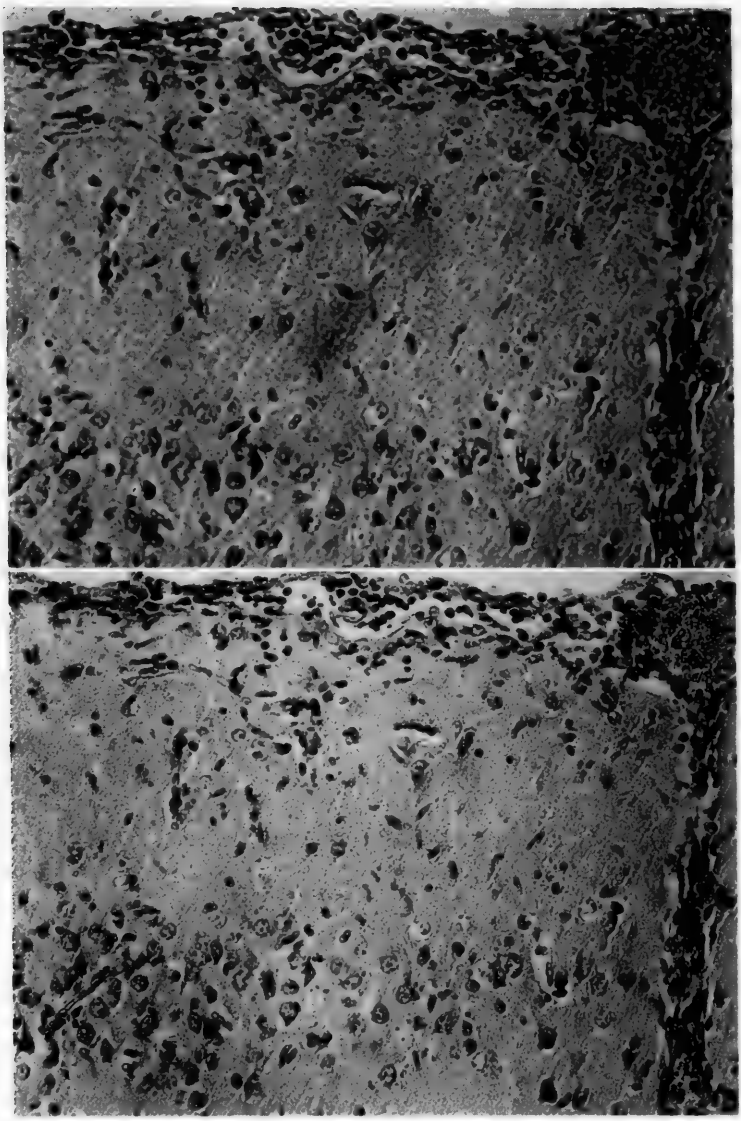

FIG. 1

plate in photomicrography.* This gives a rectangular picture of practically uniform sharpness from the center to the edges. This may be done by using an objective and ocular of moderate power with a relatively long bellows. With most stained tissues

* Journal of the Biological Photographic Association, Vol. 111, No. 3, March, 1935.

this plan has given satisfactory results; with sections of brain, however, the results have been disappointing. We have therefore resorted to the use of higher objectives combined with lower oculars and adjusted the bellows to produce the desired magnification.

A. A section of the brain of a mouse six days after the intra-nasal injection of virus of louping ill stained with eosin-metholin blue. The following equipment and data were employed. Horizontal optical bench and microscope; 16 mm. objective; Homal I ocular; two-lens substage condenser in centering mount; bellows: 38 cm.; magnification: 300 diameters; Illumination: Point O Light lamp (Ediswan) with aspheric condenser; distance from substage condenser; closed to 3 mm. was 68 cm.; M plate; G filter; exposure: 1 second.

The light was accurately centered and placed according to the accepted rules for critical illumination, and carefully focused. The result is far from satisfactory as the edges of the nuclei are woolly, the outlines of the large nuclei in the lower part are poorly defined and the substance in the background is without character. The cracks in the tissue are indistinct and fuzzy.

B. The same specimen and set up were used, except that the light unit was moved closer to the microscope so that the distance between the substage and the aspheric condensers was 44 cm. This was done to increase slightly the size of the image projected on the focusing screen. The 8 mm. objective was used with a Homal II and a three-lens substage condenser, in a centering mount. The bellows extension was 62 cm. and the magnification was 280 X. The plate, filter and exposure were the same as in A.

The difference is so great that the result speaks for itself. It should be remembered that in reproduction some deterioration is unavoidable and that in the original photographs the superiority of B over A was greater than in the printed page. The plate was slightly reduced by the photo-engraver.

PHOTOGRAPHIC TECHNIC, NEW PROCESSES AND EQUIPMENT*

F. R. HARDING

Boston, Mass.

T BINDERS

It is often desirable to cover the pubis before photographing some patients. The bandages, called "T binders," have long been a trial to clinical photographers. They usually are ill fitting and oftentimes so bulky that much is concealed which should appear in the photograph.

The writer had a great deal of difficulty for several years with interfering T binders and finally evolved an artificial binder. This is to make the negative of the patient without a binder, and then, if necessary, to paint a binder on the back of the negative, using photographic opaque. In this manner blocking of essential detail is eliminated. The artificial binder appears on the print as a small binder passing through the crotch and held by a very narrow band around the waist. It appears far more neat than the

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* From the Children's Hospital.

best of actual binders. Being connected with a hospital for children, the writer has not had occasion to employ this binder on many adults. It has been used on children from eleven to sixteen years of age. No patient has ever complained about posing completely nude nor have the parents made any complaint. The operator occasionally shows a print of a patient with the artificial binder in place to those who might be inclined to object. There should be no false modesty in medicine. Patients come to the hospital to be cured of their ills, and complaining patients should have pointed out to them that hearty co-operation between the patient and the various departments of the hospital is of great assistance.

If cloth T binders *must* be used, a design different from that used in most institutions may be employed. Replace the wide waist band with one-half inch white tape and make the apron in the form of a long triangle with a base measurement of six inches. Base measurement means the part of the apron to which the tapes are attached. A binder of this design is more neat in appearance, and has the advantage of not being expensive to manufacture.

THE WHY OF DEVELOPMENT

Metol and hydroquinone are silver reducing agents. Employed together, without other chemicals, they develop a photographic image very slowly. To accelerate the developing action sodium carbonate is added, but this causes the developing agents, metol and hydroquinone to oxidize rapidly. To prevent this rapid oxidation, a preservative is added, usually sodium sulphite. Sulphite also prevents the formation of stains. Potassium bromide is added, to prevent fogging or veiling of the negative or print.

Metol alone as a developing agent, in conjunction with the accelerator, preservative and bromide, produces a thin, flat negative with considerable detail. Hydroquinone alone, produces a dense, contrasty negative. Metol and hydroquinone are combined in proper proportions so that a negative of normal contrast and density is produced when development is carried out at normal temperature.

TRAY DEVELOPMENT OF CUT FILMS

As many as twenty-four 5″ x 7″ cut films may be developed in a tray at one time by a skilled processing room operator, without showing airbells or scratches. The developing tray should be slightly more than twice the size of the films to be processed, for example, a 9″ x 11″ tray for 5″ x 7″ films. The first film should be completely immersed in the developing solution at the left side of the tray and then passed to the right side. Then the next film is immersed at the left, lifted and placed on top of the film at the right. Continue this until all films are stacked on the right hand side of the tray. Then, starting with the top film of the stack, lift it and place on the left side, continuing until all the films are stacked on one side. Proceed from left to right and right to left until the films are developed. Be certain that the final passing over leaves the films on the left side of the tray. This brings the first film placed in the developer, on the top of the stack. Place films one at a time in the acid stop bath and then fix as usual. Fifteen to eighteen films are all that can be handled with comfort, but in an emergency, twenty-four have been developed in this manner.

The individual who wishes to try this method should start with not more than six films, as there is danger of scratching the films until one has had some experience in tray developing.

Association News

THE 1936 CONVENTION

From the very nature of the program to date, it can be predicted that the Fall meeting of the Biological Photographic Association in Boston will be outstanding. The titles already assembled and others coming in lead one to the conviction that information of great practical value will be obtainable by those members fortunate enough to attend.

Mr. F. R. Harding is the Program Chairman of the Boston Convention, September 24–26, 1936. Dr. C. T. Brues of the Department of Biology, Harvard University, and Mr. Adrian Iorio comprise the committee on the selection of headquarters—Hotel Lenox, Boylston St. at Exeter near Copley Square. The rooms for lectures and exhibition pictures and technical displays are very satisfactory and the room rates are graded to suit any purse. There is every reason to expect that the convention will be a big success.

All members are urged to plan to go to Boston. They should begin to interest their employers in the idea that participation should result in improvement of their future work. A few days release from routine work will pay big dividends to the photographer and to his organization.

Neither is it too soon to think about the material for the next exhibition; right now, members should make extra prints of the routine subjects that are exhibition material so that later they need only make the final selection.

See you in Boston!

* * *

A motion picture film was prepared by Dr. Julius S. Weingart, Pathological Department of the Iowa Methodist Hospital, Des Moines, Iowa, and exhibited at the meeting of the American Medical Association, Kansas City, Mo., May 11–15, 1936. The photography is by Robert A. Sage of the laboratory staff.

The film is a visual demonstration of the best method of autopsy technique. It emphasizes the fact that dissection, not haphazard removal of organs, should be practised, and outlines the way in which the gross anatomical lesions can be best studied. After a short prelude which stresses the importance of the necropsy as a scientific procedure, the proper type of autopsy room and equipment is shown, and the conduct of the examination is shown in detail. Each step is preceded by an explanatory title.

The film is educational in nature and purpose. It is, of course, intended primarily for the medical profession. It is an attempt to raise the standard of this important examination and emphasize its rightful place as a dignified and highly technical scientific procedure. The film consists of three, 400-foot rolls of 16 mm. motion picture film.

Miss Stella Zimmer, our Treasurer, and Dr. Groat, School of Medicine, Syracuse University, attended the meeting of the American Medical Association where they showed, in the technical exhibits, an interesting series of photomicrographs of blood.

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Mr. F. R. Harding of the Children's Hospital, Boston, read a paper, in February, on "Photography in the Posture Clinic" before the post-graduate students in physiotherapy of the Harvard Medical School.

* * *

Serious efforts are being made by enthusiastic members to organize a Washington Chapter. All those interested in becoming members should communicate with Mr. F. P. Mulgannon, 1427 I Street, N.W., Washington, D. C.

* * *

"Photography by Polarized Light" is the title of a new booklet published by the Eastman Kodak Company, Rochester, N. Y. Those interested in applications of polarized light in the fields of biology and medicine, as well as in commercial photography, may secure this booklet gratis by writing for it.

* * *

Raudebaugh has written a brief summary of the use of polarized light in motion picture photography employing the new Eastman Pola-screens. Clinical photographers will be interested in reading this article. *Camera Craft*, 42: 536–543, November, 1935.

* * *

The United States Office of Education does not have any more copies of its mimeographed circular (No. 130) on "Motion Pictures in Education in the United States" by Cline M. Koon and others. It has been printed as an attractive book and may be purchased for $1 from The University of Chicago Press, 5750 Ellis Avenue, Chicago, Ill.

* * *

We wish to welcome the following new members of the Association:

Sister Marie Bernadine, St. Francis Hospital, Hamtramck, Michigan.
John F. Brooks, 1033 Ocean Avenue, Brooklyn, New York.
Edward C. Childs, Beryllium Products Corp., Reading, Pa.
Dr. Milton Cohen, 100 West 50th St., New York City.
Morton A. Gilbert, c/o Edmonds Instruments, 915—15th St., Washington, D. C.
Dr. Samuel R. Haythorn, 5431 Baywood Street, Pittsburgh, Pa.
Harry Haber, 120 Fulton St., New York City.
Dr. Charles F. Kutscher, Medical Arts Building, Pittsburgh, Pa.
Glenn Mills, Dept. of Photography, School of Medicine & Hospitals, Denver, Colorado.
Mlle. Martineau, Departement de Photographie, L'Institut du Radium, 26 Rue d'Ulm, Paris, France.
Bruno E. Mickeleit, Surgical Research Laboratory, Massachusetts General Hosp., Boston, Mass.

William E. Patten, Office of Medical Examiner, 274 Boylston St., Boston, Mass.
Margaret Rose, The Finley Hospital Laboratory of Pathology, Dubuque, Iowa.
George F. Strong, Assistant Director, University Libraries, Western Reserve University, Cleveland, Ohio.
Will H. Towles, 3919 Oliver Street, Washington, D. C.

* * *

On May 8, Mr. Ralph P. Creer presented a paper before the Chicago Gynecological Society on the subject, "Photography of the Cervix Uteri." This paper was illustrated with a few Finlay color pictures of the cervix.

* * *

Dr. Oscar W. Richards, Chairman of the Motion Picture Committee, will spend the entire summer in biological research work at the Tortugas Laboratory.

* * *

Some excellent infra-red photographs of the nasal mucosa may be found in the December, 1935 number of "The Annals of Otology, Rhinology and Laryngology." These photographs were made by Mr. Leo Massopust, Director of the Department of Art & Photography, Marquette University School of Medicine, Milwaukee, Wisconsin.

* * *

The New York Chapter, on May 14, visited the Gravelle Laboratories, South Orange, N. J. The Gravelle Laboratories, over a period of years have devoted their efforts to the optical testing of materials by means of the microscope and camera in the production of photomicrographs for industrial and advertising use. Those attending this meeting gained a considerable amount of very useful and practical information concerning all types of photography.

On April 16 the chapter held their meeting on the premises of Carl Zeiss, Inc., 485 Fifth Avenue, New York City. The members were welcomed by Dr. K. A. Bauer, President of the New York Company, who also mentioned some of the achievements of Carl Zeiss, Jena, in the production of scientific instruments. The year 1936 marks the 90th anniversary of the founding of the Zeiss Works; while the first apochromatic objective, computed by Dr. Ernst Abbe, partner of Carl Zeiss, was made in 1886, hence 50 years ago. Mr. V. M. E. Koch, Vice President and Technical Director of Carl Zeiss, Inc., spoke on photomicrographic equipment, past and present. Microscopes and accessories, including a variety of photomicrographic outfits, were displayed and demonstrated. Of outstanding interest was a demonstration of the Micro-Vivarium, by courtesy of Dr. George Roemmert, the inventor. This apparatus consists of a Zeiss vertical projection apparatus with microscope, the image being deflected horizontally on to a screen by means of a prism. Dr. Roemmert, who has specialized for many years in the collection and preparation of material suitable for projection purposes, brought out in a notable way the possibility of studying the action of living organisms by this method. Judging by the interest shown, an enjoyable evening was spent by all who were present.

The annual election of officers of the New York Chapter was held on February 18, and the following officers were elected:

Chairman, Mr. J. A. Carlile
Vice-Chairman, Mr. F. J. Johlfs
Secretary-Treasurer, Mr. L. P. Flory

On March 10, Mr. John W. McFarlane of the Eastman Kodak Company presented an illustrated lecture on "Photography by Polarized Light."

* * *

Miss Betty Beddo has moved from Dallas, Texas, and is now in charge of the Photographic and Medical Art Departments of Hermann Hospital, Houston, Texas.

* * *

It was with a great deal of pleasure that we learned of the formation of a Pittsburgh Chapter of the Biological Photographic Association. The first meeting was held May 18 at the Falk Clinic. At this meeting a constitution was adopted and plans for successive programs were promulgated. Also, a paper was given describing Pola-screens which are employed for the elimination of surface reflections; and another was read concerning the new Kodachrome A, 16 mm. motion picture film for photographing indoor scenes and surgical operations. These papers were presented by representatives of the Eastman Kodak Company. This meeting was enthusiastically attended.

Incidentally, the Pittsburgh Chapter will be the fourth local chapter of the Biological Photographic Association to be formed.

* * *

In addition to Mr. Clarke's University of Maryland album, there are now available two copies of the album of the Rockefeller Institute for Medical Research. They show the methods worked out by Schmidt, Haulenbeek and Skelton. There is also in preparation a book containing the work of Mr. Carlile in plant photography; to this will be added as soon as possible contributions from Mr. Flory of the Boyce Thompson Institute of Plant Research. These may be obtained through Miss Florence Melvin, Dept. Medical & Surgical Research, Ohio State University, Columbus, Ohio. The Two Traveling Salons are also available to members and groups; it is desirable that the No. 1 Salon be exhibited on the Pacific Coast. We would be pleased to have some one out there undertake the direction of it.

Salon No. 2 is now in Kansas City at the meeting of the American Society of Clinical Pathologists.

We urge members to submit negatives for the Infra-Red Album of photographs. Please communicate with A. W. Fuchs regarding your material.

* * *

The Board of Directors recently voted that an amendment be published, and later offered at the annual meeting, to elect all officers and directors by mail ballot instead of by the vote of those present at the meeting only.

* * *

Mr. Louis Schmidt was recently the dinner guest and one of the speakers at the meeting of the Metropolitan Medical Association, New York City. He explained

the uses and limitations of infra-red plates in clinical medicine. The presentation was both theoretical and practical. One of his pupils in clinical and laboratory photography, Miss Greenfield, exhibited Translite transparencies of many cases photographed by her with infra-red material. Miss Greenfield is the Chief X-ray Technician at the Beth David Hospital, New York City. Much interest was evinced and many questions asked.

* * *

The Executive Board were the guests of the Rockefeller Institute for Medical Research, at luncheon, February 29. There were present, Mr. Schmidt, Miss Shiras, Miss Zimmer, Mrs. Kingsbury, Miss MacMullen, Dr. Richards and Mr. Kieffer. Mr. Carlile, Chairman of the New York Chapter, was also present.

* * *

Dr. Richards and Mr. Kieffer have been appointed to study the ways and means of incorporating the Association.

* * *

At the next annual meeting, an amendment to the constitution will be submitted to provide that future members be required to pay an initiation fee of $2, in addition to their first year's dues, with their application for membership.

* * *

The registration fee at the Boston Convention will be $3 and a badge will be furnished to serve as a card of admission.

* * *

How are visual aids and motion pictures used in America's elementary and high schools? What difficulties arise in connection with their use? How may National agencies assist in extending and improving the use of visual aids in education?

Answers to these and similar questions will soon be supplied by more than 20,000 superintendents of schools throughout the United States, as part of the most exhaustive survey ever made of visual aids in education in this country. The survey is being made by the Office of Education, U. S. Department of the Interior, and will be financed in part by the American Council on Education.

Pertinent data compiled in this Nation-wide study of motion pictures and other visual aids used in the public schools will be published by the Office of Education and will be available to teachers, school administrators, and other groups interested in visual education.

Dr. Cline M. Koon, United States Office of Education Senior Specialist in Radio and Visual Education, who will direct the national visual aids survey, said, "We hope to gain a most comprehensive picture of the status of this very important field, and urge therefore, the coöperation of interested persons in this national educational undertaking."

PROPOSED AMENDMENTS TO CONSTITUTION

ARTICLE VI

ELECTION OF OFFICERS AND DIRECTORS

A nominating committee shall be elected at the annual meeting, consisting of three members.

They shall canvass the membership and then make nominations for the offices of President, Vice-President, Secretary, and Treasurer and for the Directorships that will become vacant at the next annual meeting. These nominations shall constitute the Official Ballot. The committee shall notify the President and the Secretary of their choice before June 15th.

The Secretary shall mail to each member a copy of the Official Ballot, containing the names of the candidates and a blank space under each name, in which may be written the name of a preferred candidate. To vote, the member must sign the ballot and mail it with his annual dues, not later than September 1st.

On written request, signed by ten members in good standing, the Secretary shall mail to each member, the opposition ticket proposed by said members. Such request must be mailed to the Secretary not later than August 1st. This Opposition Ballot must be signed by the member, if he wishes to cast it in place of the Official Ballot, and mailed to the Secretary, not later than September 1st. It shall be accepted as a legal ballot.

The Secretary shall bring these signed ballots to the annual meeting and hand them to the three Tellers that the President shall appoint, to count the ballots in open meeting. Unsigned ballots, those mailed after September 1st, and those from members who are in arrears shall not be counted.

The person receiving the greatest number of votes, for each office, shall be declared elected by the chairman of the meeting.

* * *

RULES GOVERNING THE PRINT EXHIBITION—INSTRUCTIONS TO EXHIBITORS AND JUDGES

In order that the Exhibition at the Sixth Annual Convention in Boston may be truly representative, all members are urged to contribute some of their best prints. Extra prints from your routine negatives should be made now, to be selected when the time arrives for sending them.

The prints selected by the jury will be hung and will become a part of the Traveling Salon #3. They shall be the property of the Association, except Color Photographs or Transparencies, which may be withdrawn at the end of the Exhibition. Biological and Medical exhibits will be placed in separate groups and these will be subdivided into prints and transparencies, and in relation to size.

Color Photography may be delivered to the hanging committee before 11 A.M. on the morning of the first day of the Convention, but notice must have been given in advance, as to the amount and kind of space required. All other exhibits must be in the hands of committee twenty-four hours earlier. The character of the exhi-

bition will be greatly enhanced if the exhibition material is received several days in advance of the opening date.

Send prints or enlargements from your best and most interesting negatives, on glossy or semi-matte paper, mounted neatly on card boards of 22 by 28 inches or less. Under each item place a typed, or hand lettered, description of the subject, the kind, number and direction of the light or lights used. State the filter, the exposure and the sensitive materials that were used and the magnification if any. If the print is an enlargement give the size of the original negative. Place the name of the exhibitor and his organization in the lower right corner, covered with paper. This will be removed after the judging.

Lantern slides, transparencies and stereoscopy should also be shown as they are an important part of our work.

It is suggested that negatives of heads and faces be not enlarged beyond natural size. If it is desired to show lesions more clearly, it is better to show a mouth or an eye enlarged 2 to 5 times than to enlarge the head or face.

Because the field of the biological photographer is so diversified, the method of classification of entries and competitive awards has in some respects proven unsatisfactory to the exhibitors, and work of the judges has been very difficult. Each item will therefore be judged on its merit alone. On a limited number of exhibits, the pick of the show, the judges may place the Association's Blue Seal of Merit. Such exhibits must show outstanding quality, proper rendition of the form and the values of the subject and perhaps the surmounting of technical difficulties as well as excellence in negative and positive making. This award will be made irrespective of whether there is keen competition or none. If an exhibitor desires consideration based on technical difficulties, they must be definitely stated or they can have no weight with the judges.

The Gold Seal may be awarded to the best exhibit in the show. The judges must be unanimous in this decision. A certificate may be awarded for a group in research and one showing educational value.

The judges may withold any and all awards if the material is in their opinion unworthy. Their judgement shall be final.

* * *

The Photographers' Association of America will hold a national convention at the Hotel Stevens, Chicago, Ill., largest hotel in the world, from August 24 to 28 inclusive. There will be exhibits by manufacturers and dealers, and a large picture exhibit. Medals, ribbons, and seals will be awarded.

The fourteenth annual school of photography of the P.A.A. will be held at Winona Lake, Indiana. The School is intended for the advanced photographic employee who wishes to round out his experience. While not intended for beginners, those who are willing to acquire certain preliminary instruction from professional photographers in their home cities, prior to the course, may be admitted by special arrangement.

The commercial course will be held for three weeks from July 6 to 25 inclusive. The instructor-in-chief will be Edward J. Cook of the Kaufmann and Fabry Studios. The course will include all branches of commercial photography, including three days devoted to illustrative photography. Mr. Irving Manoir, artist of national note,

will deliver a series of ten lectures on art and composition. Another new feature will be commercial negative retouching by Hans Barton of Chicago. Developing and darkroom work will be in charge of Harry Elton of the Eastman Kodak Company, who will also instruct in direct color photography. Ralph Fallert, of the same company, will have charge of printing and enlarging. Charles D. Kaufmann and other guest instructors will discuss business management. Not more than 60 students will be accepted for this course, and the tuition fee is $60.

The portrait course, July 27 to August 22 inclusive, will be in charge of the director of the school, William Gerdes, only pupil of internationally famed Pirie MacDonald, Photographer-of-Men, of New York City. Assisting Mr. Gerdes for three days each will be Charles Aylett, Toronto, Canada; W. O. Breckon, Pittsburgh, Pa.; Hillary G. Bailey, Indianapolis, Ind. Little need be said about these men or their work.

The portrait course covers all branches of studio work. Lectures in business methods will be given by Mrs. Gerdes; portrait retouching by Mrs. Charles L. Pyke, and portrait coloring by Miss Martha Pyke.

Training in darkroom work, printing and projection, will be provided by the Kodak staff. Visiting instructors will include George J. Kossuth, Wheeling, W. Va., George Harris, Washington, D. C., and others. The tuition fee is $75 for this course, and not more than 75 students will be accepted.

For the prospectus, which goes into greater detail than is possible here, write to the Executive Manager, Photographers' Association of America, 501 Caxton Building, leveland, Ohio. Reservations should be made as early as possible and accompanied by remittance of $10 if for one course—$20 if for both courses. These down payments are deducted from the tuition fee.

* * *

How wool and mohair are processed and woven in modern factories is depicted in a new sound slide film produced by the Ford Motor Company and now available to educational societies, schools, clubs and other organizations upon request. The film is entitled "The Story of Wool and Mohair." Distribution of this educational film is to be made through Ford dealers who in most cases will also supply projection equipment. The film is the first of a series of illustrated educational studies for which plans have been made by the Ford Motor Company.

Utilizing the latest developments in sound slide film equipment, the educational subjects are produced with recorded explanations and appropriate musical accompaniment.

* * *

For those clinical photographers who are also radiographers a new booklet, "Intravenous Urography and Retrograde Pyelography" published by the Winthrop Chemical Company, Inc., 170 Varick Street, New York City, will be found to contain much of value regarding radiography of the urinary tract.

SOURCES OF BIOLOGICAL MOTION PICTURES

(Supplement to list published in volume 3, June, 1935)

Motion Pictures of the World and its Peoples. International Educational Pictures, Inc., 40 Mt. Vernon St., Boston, Mass. 35 cents. Brief descriptions of 16 and 35 mm. films including a number of biological interest.

Sources of Educational Films and Equipment by C. M. Koon. Circular No. 150. Free on request to the Editorial Division, United States Office of Education, Washington, D. C. A very useful list of sources for both films and equipment and in addition, lists of societies, magazines and books concerning motion pictures.

Noted Naturalist Prepares Four New Films

Four additional brand-new films by the well-known naturalist Arthur C. Pillsbury are announced for outright sale and rental by Bell & Howell Company. These are excellent classroom films, but are also of outstanding interest to people of all ages. The films are:

Life in the South Seas (1 reel). A trip to Hawaii and Samoa, giving many intimate details of native life and emphasizing the importance of the cocoanut as the "staff of life" in the islands. Time lapse photography is used to show just how the cocoanut plants germinate and grow. Two methods of island building—by coral and by volcano—are shown. A sound version is ready, a silent in preparation.

Life under the South Seas (1 reel). Shows chiefly underwater photography and how it is done. Many forms of marine life are photographed right in their natural setting. Starfish troop across the screen like trained stars of Hollywood, and obligingly show just how their stomachs work, without the aid of X-ray. A crab supports a large family of jellyfish-to-be. Here are some of the most remarkable close-up action pictures of the little-known inhabitants of the South Seas. In this picture we have the first-known combination of time lapse and underwater photography. Sound version is ready, silent in preparation. This picture may be combined with "Life in the South Seas" as a two-reeler.

Plants Without Soil (1 reel). A popular presentation of a radically new scientific method of agriculture. A single "soil-less acre" produces a ton of tomatoes, or 2400 bushels of fine potatoes at a cost of 25 cents per bushel. Scientific experimentation has been employed to work out the exact chemical diet to feed most effectively each type of plant. A copy of the formula is furnished with each reel. Time lapse photography shows plants growing and blooming. Silent version is ready, sound version in preparation.

Reproduction of Plants and Lower Animals (1 reel). A scientific biology film showing, with breath-taking microscopic details, the processes of fertilization, conjugation, and cell division (mitosis), as well as reproduction by pulling apart (budding). The spider lily, the spirogyra, the urechus worm, and the sea anemone, are the actors in this absorbing drama.

Medical and Dental Films Catalog

Bell & Howell Company has ready for distribution a new edition of its Medical and Dental Films Catalog—a listing of 16 mm. films on medical, surgical, health, dental, and hygiene subjects which are available, from their respective sources, for loan, rental, or purchase. Physicians, surgeons, dentists, nurses, teachers, and cinematographers generally, will find the catalog of interest and value.

Some three years ago this company issued its first catalog of medical and surgical films. It consisted of some twenty pages. An indication of progress and increased

interest in motion pictures in this field is to be found in the fact that the new catalog lists approximately three times as many medical and surgical films as did the first one. Dental films listings have increased in like proportion.

Significant is the appearance of a number of sound films among the silent films listed in this catalog. Beginning with the American College of Surgeons' original sound films on good hospital care, there are now several 16 mm. films available in the medical and dental fields, as shown in this catalog; and the number is rapidly increasing. The Hennepin County Tuberculosis Association of Minneapolis now has a two-reel sound film, "Contacts." In the field of child psychology a dozen sound films on Dr. Arnold Gesell's work at the Yale Clinic of Child Development are now available. In dentistry Dr. George B. Winter of St. Louis has made a sound film on the removal of the impacted third molar.

The contents of the new catalog fall under the following headings: (a) Medical and Surgical Films for Professional Use Only, (b) Health and Hygiene Films for National Distribution, (c) Health and Hygiene Films, Limited Distribution, (d) Non-medical Technical Films (e.g., "Behavior of the Feeble Minded," "Determiners of Attention"), (e) Dental Films for Professional Use, (f) Dental Films, National Distribution.

The new Medical and Dental Films Catalog consisting of 58 mimeographed pages, $8\frac{1}{2}'' \times 11''$, with cover, will be sent on request to Films Division, Bell & Howell Company, 1801 Larchmont Avenue, Chicago, when the request is accompanied by 25 cents in stamps to help defray the cost of preparation and mailing.

The Film List of the Department of the Interior

The United States Office of Education is coöperating with the American Council on Education in an effort to obtain accurate up-to-date information about all motion pictures which may be suitable for educational purposes. This information will be of material assistance in directing school officials, C.C.C. Camp educational advisers, and others, where to get films to meet their needs.

If you have produced or now own or have the exclusive distribution rights to any motion picture subjects that are suitable for such use, write to the Department of the Interior, Washington, D. C., who will supply you with film catalogue cards for listing your films with the government.

If you are at present engaged in the production of films suitable for various types of educational use, or contemplate such future production, please keep them informed of your progress and the availability of such films.

The Department of the Interior asks for the following information:

1. *If you no longer have films available* please notify us to that effect.

2. If you circulate films, either as a school system or a commercial rental agency, please send TWO COPIES of your catalog or list of films which you publish. It will not be necessary to fill in our film cards for subjects which you do not have exclusive rights to, or do not own.

3. *Films to Be Included:* In order to make a thorough survey of the educational motion picture resources of the United States it will be necessary to list all kinds of subjects. This includes:

Films showing all countries, customs, professions, or how people of the world live. This will include current events, sports subjects, explorations, reproductions of literature, historical films and other instructional subjects.

Advertising films showing industrial processes, business operations, natural resources, movements of raw stocks, transportation, and similar subjects.

Scientific, medical or technical films showing research, teaching methods, experiments, operations, medical practice, health objectives, therapeutics or similar topics.

Any other film which is suitable for instructional purposes, either in formal classroom situations, or for informal adult out-of-school groups, C.C.C. camps or other educational purposes.

The real purpose of this film survey is to locate every motion picture which has been produced that may have educational or historical value, regardless of present distribution policy.

4. *Separate Cards:* A listing on a separate card (one copy only) is desired for each motion picture suitable for educational purposes. When films are available in either long or short versions, separate cards and separate detailed synopses should be filled in.

5. *A Complete Description or Synopsis:* A teacher cannot tell from a title alone, or from a brief line or two of description, whether a film is suitable for a specific purpose. Many films are useful for teaching more than one subject. For example, a travel picture may be of value for geography, industry, vocations, customs, sports, history, architecture, transportation or other topics. A detailed synopsis is necessary in order to catalog the film properly under each of the subjects to which it is applicable. A paragraph of at least 100 words would be most useful. In many instances an extra copy of the "cutting continuity" or description of the film filed when the copyright is secured will give this information. The "dialogue sheet" alone, unless it contains information about the actual scenes in the picture, is not sufficient.

6. *All Items Are Needed:* Each item requested is necessary in order to give the agencies making this survey an accurate idea of the exact nature and possibility of each film. The information regarding the age, present location and condition of the negative and prints will enable schools and other groups to locate films of value in an expanding program of visual instruction.

Commissioner of Education
Department of the Interior
Washington, D. C.

A Government envelope and several film cards will be sent to you upon request. If you need additional cards please write for them.

A. W. Fuchs
343 State St.
Rochester, N. Y.

Book Reviews and Abstracts

C. V. NEBLETTE

Rochester, N. Y.

ASSOCIATION POUR LA DOCUMENTATION PHOTOGRAPHIQUE ET CINEMATOGRAPHIQUE DANS LES SCIENCES. SECOND CONGRESS.

In the Journal of the American Medical Association for December 23, 1933, under the heading of Foreign Letters (page 2062) there appeared an announcement of the First Congress of the *Association Pour La Documentation Photographique et Cinématographique Dans Les Sciences*. The Congress which was held October 7, 1933 was promoted by Dr. Claoué and Mr. Jean Painlevé. Dr. Jacob Sarnoff and Dr. Joseph B. DeLee of this country exhibited examples of their surgical motion pictures at this meeting.

Inasmuch as the aims and purposes of this organization are somewhat similar to those of the Biological Photographic Association, it was thought fitting that we publish a review of their second meeting.

The Second Annual Congress of the Association Pour La Documentation Photographique et Cinématographique Dans Les Sciences was held in the halls of the Musée Pedagogique, Paris, France, from October 4th to 11th, 1934.

The Congress consisted of lectures on numerous scientific subjects, most of which were illustrated with motion picture films. Among the papers published in the association's official journal is an article on "Autophoric Transplantations" by Professor Przibram of the Biological Institute of the Academy of Science, Vienna. He demonstrated with five films the art of transplantation. He first demonstrated the transplantation of insect's heads, using for example, the *coleopteras*. The head of a *hydrophilis* was exchanged with the head of a *dyticus*. Other films demonstrated transplantations made on *orthoptera*, *dixippus*, cold-blooded vertebrates, and rats.

In his paper on 'Recent Progress in Infra-Red Photography" Dr. Andre Charrioux discusses radiations and colors, the spectral sensibility of photographic emulsions, material necessary for infra-red photography, photography in total darkness and the application of infra-red photography to medicine, zoology, botany, archaeology and astronomy. Of medical importance is the use of the infra-red technique in cases of eczema. It is possible to demonstrate the changes in the subcutaneous small blood vessels directly under and surrounding the affected area. Dr. Charrioux has also been successful in making infra-red photographs of eyes affected with cataracts. The pictures revealed certain details that are not visible to the naked eye.

Dr. Fischgold presented a paper on *Some Roentgenographic Documents on Cardiac Physiology*. He employed the chronophotographic method of Marey in recording the various heart dimensions.

Dr. Weyl discussed the *Possibilities and Realization of Psychological Films.*

Dr. Hans Elias talked on the *Development of Flowers* emphasizing a technique for photographing the development of flowers with a film by making a schematic presentation and then employing direct photography.

René Beaulieu's subject was the *Utilization of Cinematographic Documentation in Meteorology.* He stressed the fact that films can be used most profitably in the teaching of meteorology.

M. Mezin presented a paper on the *Evolution of Clouds.* Pictures were taken at the rate of one per second, with a Pathé Mondial B camera, using reversible panchromatic film. A Wratten A 25 (red) filter was used to accent the contrast between the sky and the clouds, and to diminish the effects of diffusion due to haze.

Motion picture films were used to illustrate the paper by Dr. Guichard and Pélissier on *The Head in Breast and Bottle Feeding.* He points out that the correct method for holding an infant during feeding prevents certain buccal-maxillo-facial deformity.

Dr. Ch. Claoué discussed *Filmograms,* which is a method of recording various stages of plastic operations, by a series of still pictures.

Jean Painlevé presented a long and detailed article on photomicrography. He particularly stressed the importance of cinemicrography, both in black and white and natural colors. Mr. Painlevé stated that photomicrography in relief would be very desirable, although the prospect of such a technique being developed in the near future is very remote.

Fourteen illustrations are found in the entire journal.

Note: The complete report of the Second Annual Congress of the *Association Pour La Documentation Photographique et Cinématographique Dans Les Sciences* is published in French. Upon written request, Mr. Creer, Box 266, Hines, Illinois, will be glad to loan this Journal to members of the Biological Photographic Association for a limited time.

Contributed by
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